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EDUCATIONAL METHOD

MAY, 1937

A Philosophy of General Education
With Implications for Science Teaching

Influences of Science on
Human Activities

Recent Trends in Revision of
Science Curricula

Science as a Part of Living

PROPERTY OF
GRAND RAPIDS PUBLIC SCHOOLS

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VOLUME XVI NUMBER 8

EDUCATIONAL METHOD

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EDUCATIONAL METHOD

A PHILOSOPHY OF GENERAL EDUCATION WITH SOME IMPLICATIONS FOR SCIENCE TEACHING IN THE SECONDARY SCHOOL[1]

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For many years the sciences have had a prominent place in the curriculum of the secondary school. From the time of the early academies to the present, proponents of science instruction have made great claims for it as an instrument for solving the crucial social problems of the day, for liberating man from superstition and ignorance, and for helping him to arrive at a sound philosophy of life for the guidance of his conduct. Yet in spite of the elaborate programs of science instruction in our secondary schools, it must be said that only beginnings have been made in utilizing the results of technological advance for human betterment. The tested methods of science all too frequently remain isolated from application to crucial social problems, and man is still prone to keep his understandings in the field of science and his philosophical outlook on life carefully compartmentalized.

It would be unfair to ask the science teacher to assume full responsibility for our failure to make the best use of science in promoting social progress. The problem is far too complex and difficult to be solved by any one agency. The forces of tradition are too strong to be broken without concerted attack. There are too many vested interests which keep science isolated from human thinking and action to justify great optimism as to what the schools might accomplish. Yet it is not difficult to discover reasons why science instruction has not been more effective in realizing the hopes of its proponents.

As in other fields of general education, there is much confusion as to what the science program is supposed to accomplish. The secondary school program as a whole reflects this situation. As the pressure of new demands has been felt, new subjects have been added to the curriculum, while old ones, justified largely by tradition, have been retained. The result is a curious conglomeration of the so-called "academic" and the "practical" without any unifying principle to guide the teacher or the student. The result is that each field has tended to

[1] This paper in a general way presents the "frame of reference" of general education which has been worked out by the Science Committee of the Commission on the Secondary School Curriculum of the Progressive Education Association. The author, as Executive Secretary of the Committee, has drawn heavily upon the preliminary report of the committee. He assumes personal responsibility, however, for the points of view developed.

set up self-contained aims without much concern as to the possible interrelations among fields. Thus, the social sciences have been directed toward citizenship training; literature and the arts find justification in preparation for leisure time, while science is held to be particularly valuable in vocational preparation, in training in the scientific method, and in solving practical problems of living.

What would appear to be needed is a thoroughgoing conception of the meaning of general education which will serve as a "frame of reference" for all secondary school teaching, including, of course, the sciences. Having established such a "frame of reference," each field could then seek to discover its own unique contribution to the realization of the purposes of general education, and how best to organize its learning activities. This paper is an attempt to set forth in broad outline a concept of general education on the secondary level, and to indicate briefly how science instruction might contribute most effectively to the proposed purpose. While certain applications to science teaching will be made, it should be kept in mind that a program for *general education* is being proposed, which is held to be equally applicable to *all* fields which have a contribution to make to the education of adolescents in our democratic society. This point helps to justifiy the general character of the discussion.

There are two general conditions which must be met if a program of general education is to be effective. It must, first of all, be based upon the interests and needs of adolescents in our culture to the extent that they can be discovered; and, second, it must meet these needs and cultivate these interests in such a way as to contribute to the understanding, reconstruction, and refinement of the democratic way of life. Each of these aspects of the program will be considered at length.

In the past, general education at the secondary level has not been concerned with the needs of adolescents in any vital way. It has assumed that the adolescent *needed* to be introduced to the heritage of the race as it has been logically organized by the specialist—most frequently in the form of textbooks. The textbook writer was presumed to know what young people *needed,* and it was considered to be the business of the teacher to *make* the material interesting and palatable. The superior wisdom of the specialist and the teacher, contrasted with the ignorance and immaturity of the young, afforded a plausible justification for imposing scientifically organized material without giving much attention to the immediate interests and needs of youth. The progressive movement which centered attention upon the learner was regarded by many teachers with mild skepticism, to say the least. And when we consider some of the practices in certain schools which have resulted from the notion that children had, within themselves, the appropriate patterns of development, and that the teacher's sole responsibility was to remove the inhibitions which prevented "normal" and inevitable development, we cannot blame the administrator and teacher for retreating into the snug security of the textbook, and insisting that the "fad" of child purposing would soon go the way of the other panaceas which have been proposed for the reformation of education. In spite of the weaknesses of the child-centered approach, it must be admitted that it has brought about a new orientation. Instead of fitting the child to the Procrustean bed of fixed subject matter, the new approach requires that the educator study the child, not out of relationship to his environment, but rather in terms of his involvements with the culture in which he grows; not as a being whose potential powers and capacities unfold, but rather as an active, dynamic organism that grows

in interaction with a dynamic environment. Such a study is bound to reveal clues for the selection and organization of learning activities and for the utilization of subject matter. In such a program, subject matter becomes a *means* to an end, rather than the *end,* and this fact, trite as it is, makes a great deal of difference in the curriculum and in the methodology of the teacher.

The Science Committee of the Commission on the Secondary School Curriculum has found it helpful to study the needs and interests of adolescents in terms of four basic aspects of living: (1) personal living, (2) immediate personal-social life, (3) social-civic life, and (4) economic life. These categories are not mutually exclusive and are not defended upon logical grounds. However, a study of adolescent behavior suggests that they have psychological justification. The committee regards them as "convenient centers for identifying worthy interests and needs" and to some extent for organizing appropriate learning activities. Each of these four categories will be discussed briefly.

1. *Personal living.* When we consider the individual as a growing organism that steadily takes on unique characteristics which mark him off from other individuals, we discover a wide range of interests and needs which involve his physical and mental growth and which are best characterized by the term *personal living.* True, the adolescent does not have these problems apart from other aspects of the environment, but in a real sense they are tied up with the emergence of personality—with the growth of selfhood. As the adolescent moves toward an independent status as an adult, he becomes involved in conflicting practices and philosophies, and faces the task of developing a personal philosophy for the guidance of his conduct.

When we observe the behavior of the adolescent in this aspect of living, his needs as a developing, growing organism are at once evident. We also observe his need for assurance that he is developing normally, and that the physiological changes through which he is passing are evidences of normal development. We observe his need for an understanding of the nature of the world and his efforts to discover his place in it. We note his interest in working out a rational world picture and his need for opportunities for creative self-expression through which he secures personal satisfactions and a sense of achievement.

In this area of living, the science teacher has much to contribute. He can deal realistically with such problems as physical and mental health and sex education, and can aid materially in helping the adolescent to reconcile conflicts between religion and science and thus provide the structure upon which he may build a sound philosophy of life.

2. *Immediate personal-social life.* By the time the individual reaches adolescence, he is engaging in all sorts of activities which involve him in relationships with his parents, his brothers and sisters, his schoolmates and chums. He assumes responsibilities, both within the family group and among his close friends and neighbors. He holds membership in various social groups—usually in connection with his school activities. In these groups he must find his place and help to promote common ends and purposes. He develops interest in the opposite sex, and needs to develop satisfactory personal standards of conduct and wholesome attitudes toward sex problems. As he gains new and broader experiences, he becomes conscious of selfhood and of the need for establishing himself in his newly discovered world. This usually involves a gradual emancipation from home and family involvements and creates new problems of personal-social adjustment. During this

trying period, he needs the wise counsel of adults, he needs to develop a sense of security in his relationships with others, qualities of leadership, tolerance in his relationship with different racial groups, and open-mindedness in dealing with people who differ with him. These are but a few of the many needs which become evident as we study adolescent behavior. They present challenges to the science teacher, the meeting of which will lead him far beyond conventionally organized science courses.

3. *Social-civic life.* In addition to the contacts of the adolescent with his immediate personal-social environment, he becomes involved also in broader social relationships, discovers new and more complex needs, and demands a new orientation. The distinction between the immediate and wider social relationships is somewhat arbitrary but seems to be justified by the character of the problems involved and the types of subject matter useful in helping to solve them.

Orientation in this aspect of living calls for participation in social-civic institutions, such as the church, the school, and the club, as well as in local governmental institutions and agencies. In his contacts, he develops concerns with social problems such as housing, divorce, crime, community planning, community health and recreation, and governmental reform. Conflicting philosophies of dealing with social and governmental issues begin to emerge. The adolescent, though he may for some time be denied actual participation in meeting many of these issues, tends to form attitudes, beliefs, and allegiances which call for continuous reorganization of his personal philosophy. The school can aid in making these difficult adjustments by providing experiences which will help him to understand the social forces that affect the individual's health; to understand the social consequences of disease and illness; and to develop a rational view of social progress.

The contributions of science to the orientation of the individual are many and varied. In making the best use of them, the science teacher will be required to draw upon many fields that are not ordinarily regarded as belonging to the natural and biological sciences.

4. *Economic life.* It is again necessary to point out the close relationship between this aspect of living and the others which we have proposed. There are, of course, very definite economic implications in all of the individual relationships. It is, however, convenient and useful to regard economic life as a separate category for classifying a very important group of adolescent needs and problems.

The economic aspect of living includes the involvements of the adolescent as a producer and consumer of goods and services. As a producer, he is confronted with the perplexing problem of making a choice of vocation. He is also confronted with the necessity of making wise choices in selecting and purchasing goods. This category, moreover, involves his responsibility as a citizen in helping to solve problems of economic organization and control, such as capitalism versus socialism or communism, monopolies, collective bargaining, public ownership, social security, child labor, unemployment, domestic and international commerce, and the many other problems which arise in a society that is becoming increasingly industrialized. Many of these problems are bound up with the efforts of man to control the energy and materials of the natural environment.

The following are among the important needs of the adolescent in this aspect of living. There is the need for assurance of economic achievement which takes the form of a drive to participate in economic activities that have value in the adult world. A second urgent need of the adolescent involves the problem of vocational orientation

and guidance. Third, he needs to select and use goods wisely. A final need is to participate as a citizen in economic life.

In the orientation of the adolescent in this aspect of living, the science teacher has a distinctive and important rôle. He must, for example, consider technology not only as it relates to industrial development, but also as it affects human living. This implies that the science teacher must draw heavily upon fields such as the social studies, history, and the fine and industrial arts.

If the four basic aspects of living which have been briefly described are helpful for the purpose of discovering adolescent needs and problems, then it follows that the curriculum maker, whether in the field of science or in any other field of general education, would be required to make a survey of adolescent *needs,* interests, and problems, drawing upon available studies [2] which have been made, or are now under way. The results of such a survey would serve as the basis for organizing the curriculum. So-called subjects or areas would be justified for inclusion only if they could be shown to contribute to the meeting of needs and interests and the solving of problems.

Up to this point we have sought to establish one criterion for the determination of suitable curriculum activities—the needs, interests, and problems of adolescents in our culture. To meet this criterion fully would mean a new orientation of the secondary school curriculum, for much that we now teach cannot be defended upon this basis—at least not for the majority of the secondary school population. However, this criterion is, by itself, hopelessly inadequate for selecting and organizing learning activities. Needs are protean in character. They grow and expand with new life contacts. The same is true of interests and problems. All needs, interests, and problems are not of the same significance. Furthermore, they do not carry within themselves the precise pattern for their satisfaction. We need, then, some other criterion which we may use along with the one which has been suggested. For this criterion we must look to the society in which we live, and to the society of the future in which those who are now adolescents will have to secure the satisfaction of many of their wants.

It is probably beyond dispute that the schools of any society in general reflect the fundamental ideals of that society insofar as such ideals are understood and capable of being carried over into action. This idea is well expressed in the following quotation: "Every system of thought and practice in education is formulated with some reference to the ideas and interests dominant or widely cherished in society at the time of its formulation." [3] Undoubtedly, this is done most effectively in countries controlled by dictatorships in which all of the sources of information and patterns of conduct and belief are prescribed by the ruler. Such countries need not be bothered by the fear of being charged with propagandizing the schools, for there is but one set of acceptable patterns, and all citizens are expected to follow these patterns without too much inquiry into the motives back of them.

In a democracy, however, the case is different. The ideals and patterns of belief and action spring from the people themselves and are continually in the process of being reconstructed and reinterpreted. Furthermore, since democracy rests upon the intelligence of the common man, the

[2] For example, "The Adolescent Study of the Commission on the Secondary School Curriculum," directed by Dr. Caroline Zachry, and the "California Adolescent Study," directed by Dr. Marion Brown.

[3] *The Unique Function of Education in American Democracy,* p. 6. Educational Policies Commission, National Education Association, Washington, D. C., 1937.

pupil must be free to reconstruct his own beliefs, attitudes, and plans of action upon the basis of his intelligence. These two facts complicate enormously the problem of defining the function of the school in a democratic society. Yet the fact is inescapable that our schools must provide the kind of experiences for young people that contribute most effectively to the progressive refinement of the democratic way of life. This provides us with our second criterion for the selection and organization of school activities. The difficulty of applying it lies in the fact that we do not have very clear ideas of the meaning of the democratic way of life and of the manner in which a school program should be organized in order to promote it. In the next few paragraphs an attempt will be made to examine what seem to the writer to be important ideals of a democratic society that afford a sense of direction for the program of the school. An attempt will also be made to indicate some implications for practice.

Perhaps the basic ideal of our American tradition of democracy is the high regard in which the individual is held. It is not difficult to find documentation for the idea that we believe in the uniqueness and worth of individuality.[4] This basic belief is, of course, not subject to objective verification. It is rather a "moral imperative that human life has a value in itself and cannot be used for purposes alien to humanity."[5] It is a common fact of human experience that all individuals vary in their physical and mental characteristics, and that the attributes of human personality are never completely duplicated in individuals. Thus we are on safe ground when we assert that individuals, considered in terms of their complete development, possess distinctive characteristics. However, in asserting that the individual is to be regarded as unique, more is meant than the mere assertion of individual differences. It interprets democracy as cherishing these differences for the contributions which they can make to our common life, and to the enhancement of the joy of living which comes through the full development of p e r s o n a l potentialities. Hence, when we set up uniqueness as an educational value in a democratic society, we are committed to foster and develop it in all individuals. Likewise when we assert that the individual possesses worth *per se*, as opposed to the possession of mere value, as, for example, a horse as a beast of burden, we are asserting an important principle of dealing with people. If the individual is held to possess worth *per se*, his personality is not to be violated. He is not to be exploited for the gain of others. To assert that personality grows as the individual shares in common ends and purposes is merely to express our faith that democracy as a form of social organization is the best means of giving full recognition to the doctrine of intrinsic worth.

It is true that an emphasis upon unrestrained individualism cannot be tolerated in a society in which interdependence is so fundamentally a part of our tradition. As America has shifted from an agrarian to an industrial society we have witnessed the disastrous effects of an outworn concept of individualism. This is not to say, however, that we must now give up the basic respect for personality which is so much a part of our tradition, but rather that we must continuously reinterpret it in the light of changing conditions. In so doing we must not confuse the development of human personality as a goal with individualistic action as a method of reaching that goal. This idea of cherishing the develop-

[4] See Day, Edmund, "Basic Responsibilities of General Education in America." *Educational Record*, XVII (October, 1936), pp. 8-22.
[5] *The Unique Function of Education in American Democracy, op. cit.*, p. 88.

ment of the unique qualities of the individual in relation to the contributions which such development makes to social life is well expressed by Dean Johnston, of the University of Minnesota, as follows:

> As a people we believe in the dignity and worth of the individual. We should appreciate also the complete interdependence of the individual and society. The individual and his good are both the end and the means of social endeavor. The value of society is found in the opportunity for a satisfying life which it secures for the individual. The worth of the individual lies in his contribution to the strength and stability of society. Society exists for the good of all individuals, present and future; social welfare is created and maintained by the efforts of all individuals. Insofar as some individuals seek selfish, anti-social ends, and whenever society follows strange gods, purposes other than the welfare of human beings, society is weak and individuals suffer. The basic faith in the individual which is embedded in the tradition, the thought, and the striving of the American people must be continuously reinterpreted and re-implemented upon the basis of a realistic knowledge of the movement of events, ideas and interests of contemporary society.[6]

If the school were to accept this ideal as a guiding principle, it would need to give attention to the following: (1) developing creativeness on the part of individuals, (2) encouraging and providing for the development of a wide range of interests, (3) cultivating appreciations. It would also be required to exemplify in its organization and administration this basic respect for personality. This calls for a new concept of administrator-teacher-pupil relationship which has far-reaching possibilities. The school through its activities would also seek to help students to see in its own organization and in contemporary affairs possibilities of reinterpreting and applying the ideal.

A second ideal that is written large in the American tradition of democracy is the emphasis which is placed upon the sharing of common interests and purposes. More and more the conditions of American life call for a refinement of the concept of associated living, of working together with a full sense of the significance of our own acts and their contributions to the common good. Our society cherishes the method of conference and discussion in settling differences rather than resort to violence or arbitrary action. This means that we are committed, not to compromise but to the working out of solutions which result in mutual well being. It is only when men are free to deal with their differences upon the basis of common interests and concerns that we may expect progressive reinterpretation of the meaning of democratic living and an enrichment of our common life. As Dr. Bode so eloquently points out, "All creeds and social organizations are means to an end, and this end lies inside the process of living together and working together; it is not located on a far-off mountain top created by an iridescent dream. The kingdom of heaven is within us, within the everyday lives of a toiling, sweating humanity."[7] It is, of course, only within this process of social living that the first ideal, the enhancement of the uniqueness and worth of the individual, comes to full fruition.

If the school accepts this ideal of sharing of interests as one of the pillars of its social philosophy, it is then obligated to organize its program so that the school becomes an exemplification of the doctrine of shared interests. Young people will then have the opportunity of contrasting democratic action with arbitrary autocratic action, and to build their personal philosophies in accordance with the beliefs which promise most

[6] Proposed as an amendment to the "Briarcliff Statement of Social Objectives" at a Conference of the schools of the Eight Year Study of the Commission on the Relation of School and College, Columbus, Ohio, October, 1936.
[7] Bode, B. H., *Democracy as a Way of Life*, pp. 49-50. The Macmillan Company, 1937.

for the future of society. More concretely, the school will strive to organize all of its activities so as to achieve two major educational values: (1) *social sensitivity*, by which is meant "an awareness of and responsiveness to social and human phenomena," [8] and (2) to *coöperativeness*, which may be described as a process of living together upon the basis of common interests and concerns. To these values all areas of the school curriculum must contribute.

A third dominant ideal of our democratic society which is fundamental to the refinement of democracy as a way of life is the reliance upon intelligence in solving problems of human concern, as contrasted with the making of decisions based solely upon traditional beliefs, uncritical acceptance of authority, or blind impulsive action. In its broadest aspects it implies a disposition to abide by the results of reflective thinking; to forego personal bias and interest when these are ruled out by the facts; to go where the evidence points irrespective of authority, convention, or prejudice. Democracy rests upon a faith in the intelligence of the common man. Once this faith is destroyed, our only alternative course is some form of dictatorship which means the destruction of democracy itself. We must grant that the outlook is not particularly bright when we consider the extent to which we as a people yield to the appeal of the demagogue and through some of our so-called patriotic societies act in such a way as to suppress the use of intelligence. On the other hand, we can plead that the schools have never yet consciously and deliberately organized their programs in such a way as to encourage and promote intelligent action. Until this has been done, we must suspend judgment on the problem of whether or not the common man can be counted upon to use his intelligence.

The application of this ideal to the secondary school program would cut very deeply. It would mean that no problems, no creeds, no systems of belief could be walled off and kept isolated from thorough deliberation, analysis, and evaluation. Within the limits of his maturity, the student would be permitted and encouraged to formulate his own outlook on life, and to reconstruct it in the light of new evidence. Out of the welter of conflicting ideals and practices which beset the adolescent on every hand, he would seek to weave unity and consistency into his life, and the school would be committed to the task of helping him in the process rather than in determining his patterns of belief and conduct. More concretely, the school would in all of its activities make the most effective use of the method of reflective thinking, and would promote to the utmost of its powers the development of intelligent self-direction.

With these three dominant ideals made basic to the program of the secondary school, we would then be in a position to aid in the process of reconstructing and refining the democratic way of life.

By way of summary, we propose that the science teacher as well as teachers in other fields of general education set up as criteria for his program the following:

1. Is my program based upon the fundamental needs, interests, and crucial problems of the adolescent in our changing culture?
2. Does my program help to promote, enrich, and reinterpret the democratic way of life?

[8] Taba, Hilda, "Social Sensitivity." Bulletin No. 6, Progressive Education Association, *Evaluation in the Eight Year Study*, Columbus, Ohio, 1936.

INFLUENCES OF SCIENCE ON HUMAN ACTIVITIES WITH IMPLICATIONS FOR EDUCATION

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A moment's reflection is sufficient for full realization that society and the activities that go on in it are continually changing. At intervals changes affecting particular features come into prominence and continue with acceleration. These result in modification of the social organization and the changing structure is constantly the stimulus for more and more changes. Man's activities are registered in his cultural heritage and add to it and modify it. His activities in turn are influenced by the changes. An essential task of the schools is to provide the experiences through which children may prepare themselves for intelligent participation in the activities of this changing society.

Numerous illustrations may be given of development that have in relatively short time intervals caused enormous changes in the nature of human activity. The expansion of exploration immediately following the discovery of America and the changed conceptions of the nature of the earth and of its surface features are examples. In more recent times the wide application of the inductive and experimental methods for interpretations of experience have been of greatest significance.

Probably the most spectacular achievement of the experimental method has been the development of technology the extension of which may be seen as progress in control and use of energy and materials. The use of coal in industry has gone on with rapid acceleration since Stephenson set a steam engine on wheels about 1825. The use of electrical energy has increased similarly since Edison built his first generating plant in 1882. It is only since 1915 that our cultural materials have included information whereby cities and nations may be destroyed by aerial bombardment.

Of equal or greater importance, as an illustration, is the influence of the objective study of phenomena on thinking. The effect of this has been largely to annul the anthropocentric universe which had served through the ages as the framework for man's thinking about himself and about the world around him. With interpretations of time, space, and change, an ordered universe set up to serve as the abode of man seems not to be a most useful or most satisfying concept.

These changes have come rapidly. It is interesting to take stock of what men now living—take men of seventy as a familiar reference interval—have lived through. When they were born electric lighting was unknown, and most of them who were college men had finished their college careers before having seen an electric light. They had passed middle life before the nation had become conscious of problems associated with agricultural use of marginal farm lands; and they were approaching old age while we still lived in the horse-and-buggy days. Through their youth and maturity authoritarian religious pronouncements of what was required to achieve eter-

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nal life served as forceful influences affecting beliefs and behavior. Public education, in comparison with its present influence, was of much less importance. The contrast of facilities for travel and communication in 1900 (when these men were 33 years old) with that of today is indeed striking. And still change continues. Old men are overwhelmed by the changes and long for the good old days. For young men, it is the world into which they are born and from which they must obtain the stimulation that will guide them to achieve their portion of happiness and satisfaction.

Human activities and the changes that result from them are not chaotic, at least not entirely so. Intelligence functions in action and gives it direction. Intelligence enables man to formulate his desires and to anticipate his needs. The common biological characteristics of man tend to give to these needs and desires a quality of universality which, incidentally, we tend to neglect in our emphasis on individual differences. Desires which are obvious are for efficiency in the maintenance of life and for happiness and satisfaction in living. Human needs are for attainments that will accomplish these desires. Man uses his intelligence to meet these needs and thus gives direction to his activities.

Within the broad range of human desires we may recognize some that are specific and persistent. These include desires for physical vigor and for mental alertness adequate for maximum participation in life activities; desire for efficiency in production of materials and conditions necessary for satisfactory maintenance of life; desire for leisure for recreational and æsthetic activities; desire to interpret the sensations arising from internal and external stimuli—to understand oneself and the world; and a desire for social organization adequate for individual protection and for fullest expression of activities leading to enrichment of individual and group life. An analysis of human activities seems to support the conclusion that desires furnish the impetus for action and at the same time give direction to it.

The influences affecting man's intellectual life, and particularly the manner in which he meets his needs, are his understanding of the world, of himself, and of his social organization. These understandings are the fabric of his world-model (Weltanschauung) and this serves as the framework for his thinking.

Man's understanding of the world includes his concepts of the nature of the physical universe and its history, of living things and their history, and of the processes in nature and their potentialities for human welfare. His understanding of himself includes his concepts of the nature of physiological and psychological functioning. His understanding of social organization includes his concepts of desirable relationships within the family and within the Great Community.

These influences affecting intellectual life include the major concerns of mankind and all the great areas of thought have contributed to the working understanding that we have of them. These great areas include science with its many related areas of specialization, the social studies including history, literature, the arts, philosophy including ethics and religion, epistemology, and others. In this discussion we are concerned primarily with the contributions from science. A brief overview of this broad field will show something of its contribution to understanding of the influences affecting intellectual and emotional life and the potentialities of its contribution to the use of intelligence in human activities.

1. *The physical universe.* According to most careful thought at this time the physical universe, from atoms to galaxies, is a vast system of parts moving and changing, these changes being accompanied by, and

resulting from, a flow of energy and ordinarily tending in a direction favoring equilibrium of existent forces.

The earth is a body of the solar system held in its course by the interaction of the forces of inertia and of gravitation. It moves with circular (relative to the sun) and rotational motion with the angle of its axis of rotation and the plane of its orbit nearly constant. Its spherical surface turns in the rays of the sun and the vertical ray shifts back and forth across the torrid zone as the earth revolves about the sun. Solar radiation is the main source of energy for the earth, and the region of greatest intensity is the region of the vertical rays. Energy is carried chiefly by wind and water and flows over the surface of the earth in directions favoring establishment of equilibrium of involved forces. The motion of wind and water causes erosive changes in the earth surface and, influenced by the force of gravity, the material of the earth's surface is moved from higher to lower places. Thus mountains are slowly worn down and the seas are slowly filled. Movement of matter from one position on the surface to another causes strains within the earth and these strains are released by uplift and depression or other movements which cause distortion of the earth's crust. The material of the earth is composed of some ninety elements, the atoms of which are assumed to be composed of energy particles known as electrons, protons, neutrons, and positrons (possibly others). The atoms are believed to differ from each other only in the number and arrangement of the energy particles which are held firmly in their composition. Radiant energy comes to the earth and leaves it at a uniform rate. Most of the forces on the earth have their origins directly or indirectly in solar radiation.

Careful observation and study of the results of changes on the earth furnish convincing evidence of the succession in which events have occurred and furnish some evidence of the time lapse between successive events, but there are no observations from which we may conclude when the earth began or when it will end. Observations outside the earth indicate that the sun is a star in a vast galaxy and that this galaxy is but one of many distributed through the vast reaches of space. Thus we see the earth as an entity in a universe which in practical considerations seems unbounded in space and in time. Such in the large are the interpretations which man has drawn from his observations of the physical features of the world.

2. *Life.* A living thing is maintained by selective and balanced exchange of materials and energy between it and its environment; it is characterized by response to its environment, by reproduction and a definite life cycle, by variation from generation to generation with a tendency to develop in complexity through the ages.

All living cells are characterized by response to their environment. They display the power to use matter and energy in the processes of growth and development. They select and use certain materials from the environment and reject or tolerate other materials. The processes that go on in living cells and the processes of decay after death restore the materials of which living things are composed to the soil and air to be used again in succession by the plants and animals that come after. No living thing lays claim for long to the materials of which it is composed.

Living things die, but life is continuous. In sexually reproducing organisms it is carried from one generation to the next through the agency of specialized cells. Characteristic traits are carried as if by discrete particles called genes, and in the process of reproduction traits characteristic of one parent are mixed with traits charac-

teristic of the other and the new individual shows traits of both. The genes also determine that the new organism shall be fundamentally similar in structure and function to the parent. The organism responds to environmental factors and is adapted within a limited range to changing conditions. The stream of life has been continuous through the vast ranges of geologic time, and observation of fossils supports the conclusion that through all this time it has been changing. In general the changes tend toward increase in complexity in structure and function. The changes favoring survival are those which favor effective functioning in the environment. Thus changes in the environment give direction to changes in living things.

3. *Interrelations and interdependencies.* Living things influence other living things and the conditions about them by their presence in a situation, by their behavior, and by their products.

Lichens grow on rock and take from it and from the air the chemical elements necessary for growth. These processes of growth make conditions that are favorable for mosses and these, while serving as food for a sparse animal population, prepare the way, with favorable climatic conditions, for more luxuriant plant growth and for an animal population of increasing density. The capacity of protoplasm for variation favors the distribution of life through all physical conditions on earth. Only the most severe extremes of heat, cold, or dryness in a region can prevent the spread of protoplasm through it. Organisms live in the drylands and tend to establish equilibrium in the exchange of materials between themselves and their surroundings. These materials are scarce in the drylands and only a sparse population of plants and animals can develop there. At the other extreme are the conditions of the rain forests of tropical regions. Here the materials necessary for growth are abundant and conditions are favorable. Trees grow dense and tall, and vines entwine them. Parasitic and epiphytic plants encroach upon their branches and a dense population of animal life feeds upon the luxuriant growth. Between the extremes of the tropical rain forests and the deserts are plant and animal life in decreasing density in population. In primitive societies man is an organism living approximately in dynamic equilibrium with other organisms and his environment. Under the influence of the human intellect existing equilibria are disturbed and new ones tend to become established. The greater the departure from the primitive equilibrium the greater the demands upon intellect for the maintenance of society, and conversely the greater the influence of the intellect the more the equilibrium departs from the primitive. Thus does our society grow complex.

4. *Control.* The maintenance and extension of contemporary civilization depends upon man's ability to control and use to his own advantage living things, energy, and the materials of the earth's crust.

4a. Man is attaining increasing power to control and use living things. He is using these attainments for the maintenance of life, for pleasure, and for industrial purposes.

The desire for physical vigor has functioned as a powerful drive to achieve understanding and control of the causes that operate against it. In general these are identified as parasitic organisms and viruses, dietary deficiency, glandular disturbance, and malignant tissue. The successes of sanitary measures in the control of diseases caused by parasites and viruses and the use of serums and other agencies in their treatment are well known. Understanding and control of disorders resulting from deficiencies in diet and glandular functioning rank among the great scientific achievements of

more recent times. These are the controls which man uses in his efforts to maintain his bodily vigor.

Controls in plant and animal breeding have resulted in production of plants and animals to serve a great variety of purposes. Plants are bred for increased and improved production of commercially valuable plant products, for decorative and other purposes. Animal breeding has increased and improved animal products and has resulted in production of animals to serve man better and to satisfy the whims of "fancy breeders."

In production of foodstuffs soil control is of great significance. There is positive basis for conclusion that greater efficiency will result from intensive farming of limited areas with effective controls than has resulted from extensive farming of unlimited areas with ineffective controls.

4b. The control and use of energy from natural resources is a recent achievement in the history of the race. Until very recent times the race was limited in its energy resources to that which could be obtained through use of its own muscles and the muscles of beasts of burden. So long as this was true there were positive restrictions to the efficiency which man could attain in maintaining himself. Foods could not be produced in sufficient quantity to maintain many great cities. Muscular energy is incapable of driving machines at high speed with heavy loads, for generating electricity for commercial use, or for driving the machinery of great manufacturing plants. The extension of control and use of energy for industrial purposes has gone on at a greatly accelerated rate. It is in fact conservatively estimated that more than half of the total of man's mechanical utilization of energy has been since 1900. Energy is potentially abundant and may be made available in quantity sufficient to serve every practical, if not indeed every conceivable need.

4c. Along with increase in mechanical utilization of energy has gone increase in utilization of material. Through the use of machines we fashion materials from the earth's crust and products from plant growth to serve our needs. As in the case of energy, materials are potentially abundant. The crust of the earth is the reservoir and there are no practical limitations to the quantity available for use except as limitations are artifically set up.

5. *Epistemology*. Man has the power of recalling and reflecting on his experiences, of directing his behavior with reference to the relatively distant past and future, of critically evaluating the results of his own thought. He alone has a social heritage.

Workers in science as in other great areas of thought have developed methods of interpreting experience. The chief contribution of the sciences is the refinement of methods of inductive thinking through use of controlled observation and the experimental method. Through its achievements science has impacted and influenced the whole range of human action and has in many particulars forced a re-examination and revision of previous interpretation of experience.

This brief review calls to mind the major achievements of science and suggests some of the actual and potential influences of these achievements on human action. In considering the problems associated with the attainment of increase in the use of intelligence in human action, attention must be centered not only upon scientific achievements but also upon scientific methods. The methods of science are non-authoritarian but unfortunately the findings of science too often reach the popular mind only as authoritarian pronouncements.

The cause of this remoteness of science as method from problems which arise from human activities must be sought in the agencies of education, including the schools. The popular science of the radio and the

newspaper is often a combination of trivialities and "wonders" presented as miraculous and mysterious happenings. In the schools the sciences are not uncommonly presented through experiences that are foreign to immediate interests and often not acceptable to students. The results touch life in the schools largely through mechanical applications and authoritarian pronouncement.

It is a matter of common knowledge that the scientific method of inquiry and investigation, through the use of observation and experimentation, are used extensively only by a comparatively small number of specialists and by these most frequently in investigations relatively remote from immediate human interests. Science has in large measure constructed the social scene in which action goes on. Our program of education has not been effective in bringing to the popular mind an ability to use in the social scene the methods of thinking that have produced it. Scientific method remains in large measure an agency working outside the social organization which it has so largely influenced, and activity within the organization goes on largely under the direction of tradition, dogma, and emotional appeal. In this condition confusions and conflicts are bound to exist. Dewey and Childs strongly support their argument for a wider use of the scientific method as a partial corrective for the ills of society in their discussion of the social-economic situation and education. They conclude that "education possesses in scientific method a potential agency for ridding the present situation of its confusions and conflicts and for making the transition to a society which will be emancipated from many of the undesirable traits of present life that have been indicated. To make this potential actual and operative, the method must be simplified and generalized. This will take place when *experimentalism* is realized to be the heart of science as method of discovery and test. Experimentalism is the cause of the victories won by science in the physical field, while the social field is kept as a preserve sacred from the free use of experimental procedure. The result is unbalance, distortion, and misuse of the physical fruits of science. Those who hold the remaking of institutions and traditions is as much the office of conscious education as is the transmission of values attained in the past will not see their ideal realized even in a fragmentary way until the formation of an experimental attitude of mind becomes the unified and unifying goal of education in its intellectual phase." [1]

These considerations present a challenge to pursue studies of processes and outcomes from teaching and learning. What are some of the challenging questions for investigation? The findings of science take on meaning only as they are generalized and related to the influences affecting human activities. The process of generalizing is used by everyone as a basis for action. Often it is done from inadequate, erroneous, and conflicting premises. Nevertheless, the process of thinking which goes on either in the mind of the immature child of low I.Q. or in the mind of the intellectual giant of science or philosophy has common characteristics which make it identifiable as the process of generalizing. What may we do through education to improve those processes of generalizing which are necessary and inevitable in life? The concepts of modern psychology furnish a framework for the experimental investigation of this question.

The second question suggested for investigation relates to scientific methods. Reflection suggests that scientific methods have remained remote from life because the ex-

[1] Dewey and Childs, "The Social-Economic Situation and Education." *The Educational Frontier*, Yearbook Number XXI of the National Society of College Teachers of Education, Chapter II, pp. 61-62. D. Appleton-Century Company, 1933.

periences through which these methods have been presented in the schools are remote from life. In the main the experiences are those of the specialist in his laboratory as he makes a discovery. Such experiences may be fruitful for the individual preparing for specialization in scientific research but they are probably not very effective for preparing an individual to use the experimental method in his personal and social life. But, as in the instance of generalizing, every person uses some methods of inquiry as he looks out upon life in action and as he takes part in it. What may we do through education to improve the methods of inquiry which are used in dealing with the activities that are necessary and inevitable?

Practically the process of experimentation and related aspects of scientific method cannot be carried on apart from the processes of generalizing. The effectiveness of the learning experience in developing ability and disposition to use the scientific method in personally or socially significant experiences is greatest when the learning experience is itself of personal or social significance.

This analysis of human activities and of the influences affecting them reveals something of the complexity of our society and something of the difficulties attendant upon education for intelligent participation in it. Science and other great areas of knowledge have contributed to its making. Effectiveness in education seems to require that education be in a setting that is of individual or social significance and that it be carried on with recognition of the factors affecting the activities of the individual and society and with equal recognition of the methods of thinking that have brought these factors into being.

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RECENT TRENDS IN REVISION OF SCIENCE CURRICULA

As Found in the Thirty Schools Participating in the Experimental Study Under the Commission on the Relation of School and College

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In formulating a school program unhampered by any imposed restrictions it became necessary for each school staff to achieve, through discussion and a "free for all" give-and-take, a common philosophy of education. In order for this philosophy to function effectively, most school staffs found it desirable to have it expressed by a set of objectives stated in terms of the behavior changes they would like to see brought about in their students. What kind of boys and girls should be coming from the schools as the final products of the combined impacts of home life, school experiences, and the general physical and social environment?

Stated very briefly analysis of the objectives of the schools shows that they are concerned with behavior changes in five main areas:

1. *Fundamental skills and abilities.* In all of the schools, interest in the development of the fundamental skills is still a major consideration. There is a tendency to give careful analysis, however, to a diagnosis of student needs in order to determine which skills and abilities are really fundamental rather than traditionally fundamental. There is a tendency also to ask the question, "fundamental for what?"
2. *Coöperation.* In a society aspiring toward complete democracy as an ideal, coöperative individuals are required. In such a society group problems are solved by groups of individuals; consequently, skill and willingness to work with and for others seems to be a valid objective.
3. *Appreciations.* Broadly speaking, teachers feel that in developing appreciations in their students they are aiding them in the achievement of a stability of mind that will enable them to live self-satisfying lives. "Developing a Philosophy of Life" might almost be taken as a synonym for the term "Appreciations" and have the meaning clearer. For the most part teachers are not trying to indoctrinate their students with any one philosophy, but they are interested in helping them to formulate for themselves a scale of beliefs that will make for greater stability.
4. *Critical thinking.* The development within students of a clear understanding of and the habit of practicing the scientific method. "Reflective thinking," "problem solving," "logical thinking" are terms that might be used in place of the chosen term, "critical thinking." Teachers are concerned that this ability be both possessed and practiced by their students. Ability divorced from action has little value.
5. *Health.* It is desirable that students achieve good health, both mental and physical, and have a knowledge of and a willingness to apply the principles and generalizations making up our fund of information in this area.

As there is no imposition of curricular materials, courses of study, teaching techniques, or examination systems upon the

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participating schools, there is wide variation in the content and procedures used in furthering their objectives. Probably the greatest asset that the experimental study has is to be found in the personnel of those responsible for curriculum revision. In practically every case it is in the hands of the classroom teachers and not in the administration or a special staff appointed for the purpose. The work is distinctly experimental. The revisions are in a constant state of flux which shows at present very little tendency to crystallize. I believe this state of affairs to be wholesome. Too many curriculum revisions of the past have been made by arm-chair specialists, thorough masters of their fields, but the fact that their programs were administered by teachers who had had no share in the formation robbed the programs of much of their effectiveness. Curricula, like objectives of teaching, function best when made *by* teachers and not *for* teachers.

The tendency shown by most curriculum designers has been to consider the subject matter first and then derive grade placement in such a way that subject matter was completely integrated with prerequisites amply covered at each stage of the game. This approach is responsible for our present courses in physics, chemistry, biology, and other sciences, all good for the future specialist, but the assumption that they are also the best organizations for the non-specialist is being questioned by many teachers.

It would be well at this point to remember that this discussion is concerned with "trends" of revisions and that the generalizations which follow cover thirty different schools. To no one school will all the generalizations be applicable. Then, too, the word "trend" implies direction of movement and is very true in this case. In very few schools have these trends been developed to the point that the teacher is willing to consider the problem solved.

Objectives of Science Teaching

The first need in any problem of curriculum design is a definite and concrete set of objectives. There is nothing new in this approach to the problem, but in most of the experimental work there is evidence of the use of three criteria in the statement of objectives that is significant: (1) the objectives of the science instruction must contribute to the general objectives of the school; (2) the objectives must function as criteria for the selection of either content or method; (3) the objectives must be capable of evaluation. The first of these criteria definitely rules against the specialized type of science course. It becomes necessary for the science teacher to become more of an educator and less a teacher of specialized subject matter. The step is a difficult one for most teachers to take. The third criterion is a stringent one. It eliminates wishful thinking and necessitates concrete statement rather than glittering generalities which are impossible of application. Many of the objectives set up by teachers are neither new nor revolutionary, but the fact that they have been formulated *by* teachers and not *for* teachers plus an insistence that their work be appraised in terms of their objectives gives them a potency that is far-reaching in the effect upon choice of both content and method.

It is interesting to note that few of the objectives are stated in terms of subject matter. Almost without exception teachers are interested in developing attitudes, appreciations, habits, skills, and abilities. This means again that the objectives are stated in terms of desired behavior responses on the part of boys and girls.

Is he openminded?
tolerant of other people and new ideas?
free from superstition?
actively curious?
intellectually honest?

Is he in the habit of suspending judgment
until facts are known?
aware of the contributions of science
to our way of living?
aware of the problems created by science as well as the problems solved
by science?
Does he have a reasonable expectation of the ability of science to solve our problems?
Can he distinguish between fact, theory, assumption, generalization?
Does he have the ability to
recognize a problem?
set up a hypothesis?
collect and organize data?
draw conclusions from data?
derive generalizations and appreciate
their significance?
apply facts and principles to new
problems?
distinguish between cause and effect?
recognize multiple effects from a single cause rather than consider them
in causal relationship?

In working toward such objectives teachers are not in a state of *unconcern* over content. They are concerned with the *use* of content to achieve growth toward the objectives, which are of primary concern.

Content

Most of the teachers are extremely reluctant to distribute their courses of study in terms of content. Many of them do not have courses of study in terms of day-to-day activities, laboratory exercises, or specified factual material. They do have a curriculum in terms of generalizations, principles, or concepts, but the daily activities may vary from year to year or, in the case of teachers teaching more than one section, from class to class. Teachers are interested in aiding students to *derive* the principles and generalizations, but the avenue of approach is not their primary concern. For the most part they are using the same old building blocks they have always had at their disposal. Very often the completed blueprint of the final structure is traditional in form and general lines but the workmanship, hidden to the casual observer, is often, though not always, of superior quality.

Where organization has been varied from traditional, it quite frequently takes the form of integration of one type or another. Some of these fused courses are within the science field itself—physical science, fusions of physics, chemistry, and often of geology and astronomy. Fusions of chemistry with biology and science with mathematics are somewhat rarer in their occurrence. In one school a serious study is being given to a fused course in science and social studies. In another school these two areas are integrated within a single class without the external characteristics of integrated programs, such as: a single classroom teacher, two coöperating teachers in one classroom, concurrent treatment of content materials, etc. Most of the integrated courses in physical science are designed specifically for the consumer group rather than for the budding specialist, but the courses serve as foundation for half-year courses in physics and chemistry offered as electives at the twelfth year level.

Increased attention is being given to health education. Much of this is somewhat indirect, the material being included in other courses. For example, one school defines the function of the biology course as: "The orientation of the pupil in his physical, biological, and social environment." The school proposes to aid in this orientation by providing study experiences in the following working centers: physical health, mental health, emotional stability, social adjustments, creative self-expression. The course should not be called biology, but at least it looks most interesting and offers promise of being significant. Other courses in biology include units of work on such topics as,

Digestion
Posture
Sex hygiene

Reproduction
Disease control
Sanitation, personal and community
Bacteria and their control
Disinfectants
Patent medicines
Popular superstitions
Cleaning agents

A course in chemistry from another school considers such topics as

The chemistry of water in body functions,
of food within the body,
of glands,
of bacteria control,
of drugs and medicines,
clothing, cosmetics,
of water purification, cooking.

Again the criticism might well apply that this is not chemistry; but, no matter what the name, may it not be meeting the needs of boys and girls more effectively than most courses in chemistry?

Another important trend in curriculum organization is being called the "source unit." Source units are organized bodies of material not taught as units but defining the content, bearing upon some long-time problem of boys and girls. The first of these to take form is a unit on sex education. It is defined in terms of principles, generalizations, and concepts. Factual content is also included; teacher and pupil bibliography is tentatively formed. This unit is then carefully studied for grade placement and taught when it seems desirable either as a small unit of material or in conjunction with science instruction in some other course. Other fruitful fields for the definition of source units are: matter, its composition and changes, energy and its transformations, public health, transportation, communication. The possibilities of this unit type seem unlimited. They might well serve as a check sheet for the teacher who likes to start with pupil interest and lead off from there into deeper water.

A few trends in methodology are apparent. They are not new but are being mentioned because of the very apparent increase in their occurrence. There is an increased use of the laboratory showing a tendency to discard the "cook book" type of laboratory manual and to substitute in its place a problem-solving type of experiment. There is an increase in quantitative experimentation and a decrease in verification and descriptive experiments. Descriptive experiments are widely used but in the form of demonstrations frequently given by students. There are fewer experiments attempted but those done require more sustained effort and consultation with a variety of source materials. There is an increase in individual experimentation and a decrease in the number of lock step, routine, laboratory experiences. There is wide use of the student report with definite training in the art of making reports. There is more extensive reading in the popular and semi-popular science literature, in histories of science and current magazines and less use of a single text. Many teachers are meeting the problem of minimal standards of achievement by setting up multiple standards obtained by conference, with individual students setting up specific individual objectives. The boy who expects to specialize in science is given more laboratory experiences and is held to high standards in the development of the specialized skills (equation writing in chemistry, etc.) while the non-specializing student is encouraged to read more widely in the semi-popular literature of science.

Evaluation

The third criterion for the selection of objectives has necessitated an attack upon a second problem, namely, evaluation. Teachers have not been satisfied with existing tests as they gave no specific data on many of their objectives. For this reason, many science teachers in the thirty schools are

working on instruments to be used in a comprehensive testing program. If the content and methodology of science instruction are to be used to develop desirable habits, attitudes, appreciations and skills, the degree to which they are being achieved must be determined. The need of determining student growth is evident. It is needed by the pupil and by the teacher and must be convincing. Adequate programs of evaluation can do much to give both teacher and pupil a feeling of security. Overcoming insecurity on the part of the student is more necessary in experimental curricula than in traditional ones. This is also true for the teacher. With tradition and generally accepted patterns of procedures no longer supporting the program and giving the participants a feeling of stability and rightness some substitute must be available. Clearly defined and accepted objectives, checked by suitable means of appraisal, offer this stability. From the standpoint of curriculum building as a research problem, evaluation instruments are badly needed in order to pass "value judgments" upon both content materials and methodology. Which one of two or more methods of study pays the highest dividends in student growth? What content accomplishes the desired goal with the greatest economy of time?

The testing programs have been expanded. More but shorter tests are given. Tests are designed to show evidence upon a single ability, habit, or skill in order that the data will have diagnostic value to be used for guidance purposes, for outlining remedial work, for dictating classroom procedures, and for validating content. Such test items must not be included in tests on factual material or their diagnostic value is lost. This means pre-testing on factual material or the setting up of testing exercises in which all the facts are presented to the student within the body of the test itself. Both methods are in use.

The experimental work being done by the teachers is under the direction of Dr. R. W. Tyler of Ohio State University and a staff of very capable assistants. A coöperative attack is being made upon the problem and in every case a classroom teacher is very active in the program. In many cases this requires a great deal of research as many of the teacher objectives fall in the realm of the "intangibles" and present methods of evaluation are ineffective in this area. The staff at Ohio State serve as consultants, advisers, and aids, but the classroom teacher determines the objectives to be tested and participates in the research. Many of the techniques now under study offer great promise of value.

At the present time considerable progress has been made in designing tests to measure:

Ability to set up a hypothesis
Ability to interpret data
Ability to distinguish between fact, theory, and assumption
Ability to distinguish between cause and effect
Ability to make accurate observations
Ability to apply principles and facts to new situations.

Paper and pencil tests of the above type and the standard forms of objective testing for content mastery are supplemented in many places by the use of anecdotal records, interviews, questionnaires, and parent conferences. While evidence from such sources is of little value in ascribing letter or percentage grades to students, their value in providing significant material for guidance purposes cannot be overestimated.

It is only fair to state that the problems yet to be solved are legion, but results are sufficiently encouraging that teachers are eager to continue. They are humble when facing the responsibilities that are theirs—responsibilities to students, for boys and girls are not guinea pigs and cannot be treated as such, responsibilities to others in the teach-

ing profession who have not been granted the freedom to experiment.

To summarize briefly, the present trends seem to be:

1. Setting up objectives that are significant in choice of content and methodology and which contribute to the objectives of the school.
2. Greater emphasis in teaching for habits, skills, abilities, and appreciations.
3. Definition of content in terms of source units.
4. Individualization of work within a class.
5. Greater use of the laboratory as a problem-solving work shop.
6. The fusion of sciences by a problem-solving approach.
7. Greater attention to health education.
8. Greater attention to consumer education.
9. Testing for the objectives of instruction rather than content testing alone.

The writer is willing to draw three tentative conclusions from his observations of the work in the thirty schools: (1) It is impossible to separate curriculum, methodology, and evaluation into three small isolated compartments and work on problems within one area at a time. (2) That of the three aspects of curriculum revision discussed in this paper, *curricula,* as defined by content materials alone, is the least important. (3) That the benefits that come to teachers engaged in research for better materials, methods, and procedures are so great that they should be coveted and sought for by every member of the profession.

TEACHING THE PHYSICAL SCIENCES FROM A FUNCTIONAL POINT OF VIEW

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If science courses in the secondary schools are to serve any very vital purpose, if they propose to make any very significant contribution to the lives or to the thinking of the children who enroll in them, then it is imperative that science teachers consider carefully the evils inherent in the traditional pattern that they have too long been following. No subject field in the school curriculum has more possibilities of interest, motivation, and real significant contributions to more intelligent and to more enjoyable living than has the science field—and yet there is scarcely an area in which the teachers have been less critical of their materials, their procedures, or of their results than have been the teachers of science.

This situation has undoubtedly resulted from a series of fairly obvious causes. The sciences have been so well organized from a subject matter point of view that it has been difficult to realize that perhaps this very logical, carefully constructed pattern of knowledge, admirable though it may be from the science angle, is not a particularly appropriate organization for the secondary school, either from the perspective of the child's interests and needs, or judged by the criteria of educational psychology and our knowledge of the learning process. The determining influence of the College Entrance Examination Board, the accrediting practices of state universities, and the influence of college and university admission committees in recognizing standardized course credits have all been influential in maintaining the "status quo." The rapid multiplication of the content of the physical sciences in the past quarter of a

century has served only to confuse the science teacher and to inspire him to cling even more closely to the security of the "fundamentals." There is safety in the traditional and familiar concepts of Boyle, Dalton, and Avagardro; percentage composition and normal solutions provide intensive exercise and drill; while the routine laboratory experiments with chlorine and oxygen supply that element of "cookbook" technique which, combined with the practice of filling in blank spaces on a printed sheet, fulfil the laboratory requirements of the colleges.

It is, however, not sufficient to consider carefully the evils inherent in the present general practices of science teaching. It is equally important that the significant, though latent, possibilities of science instruction also be considered. We are living in an age of science—a trite statement often heard but apparently given little serious thought—but we are not living in an age of pure science, if there be any such thing; rather are we living in an age where our every activity is conditioned by practical applications of science. And a startling thing is that frequently the application is not only more interesting and more valuable to the child than the theoretical science upon which its foundations ultimately rest but is also much more understandable and meaningful to him.

If we are, then, living in an age where applied science is playing a stellar rôle, it would seem that the school would make an effort to help the child interpret his surroundings so that he might make intelligent use of the many applications of science constantly at his disposal, that he might more fully enjoy his contacts with the fruits of scientific progress and achievement, and that he might have a deeper sense of the significance of the onward march of science in terms of the other aspects—social, economic, and political—of the world in which he lives.

At the Francis W. Parker School we are attempting to work out a two-year physical science sequence for the eleventh and twelfth grades which will provide for our students the maximum benefits of science study. We feel no allegiance to the traditional patterns of science teaching nor have we any false loyalties to the sciences themselves. We have no sacred obligation to teach boys and girls how to balance sterile equations or to manipulate abstract formulæ. Our interest is centered in the boys and girls themselves and in an honest effort to provide for them the greatest possible good which can be derived from science experiences. We do not shy at facts or formulæ nor turn our backs upon technical or theoretical material providing such factors are necessary to an intelligent understanding of the work which is being attempted. The point is that we use such materials not for their own sakes but as explanatory data or devices to give the real subjects of our study meaning.

Having now set up a brief argument in support of our functional treatment of science,[1] let us turn to a more detailed account of the way in which the course really functions. In the eleventh grade the units are chosen largely from the area corresponding to traditional physics, while in the twelfth grade the greater part of the units deal with subjects in which chemistry is most apparent. In neither case, however, are subject matter lines drawn, as any and every aspect of the unit that may seem to be significant will be included. The tentative list of units planned for the two years is given here:

PART I

1. Introduction: Aims, purposes, procedures, and general scope of the course presented to the group in informal discussion fashion.
2. Measurement—a fundamental tool of science.
3. The Kinetic-Molecular Theory of Matter—a basic theory of science.

[1] For a more detailed discussion of the philosophy involved, see author's article, "A Functional Course in the Physical Sciences," *Curriculum Journal*, January, 1937, p. 13.

4. Water—a necessity of life and a substance of great value to science.
5. The atmosphere and its relation to life and to science.

PART II

6. The automobile—a synthesis of many scientific principles.
7. The electric refrigerator—making practical use of molecules.
8. Musical instruments—the science of sound produced for pleasure.
9. Geometric optics and illumination—the science of seeing.
10. Electricity in the home—man's greatest servant.

PART III

11. How metals are made available for our use and their importance to us.
12. How we use some of our natural resources for producing heat, light, and mechanical energy.
13. Nitric and sulphuric acid—handmaidens of an industrial society.
14. Making and using soaps, cleansers, dentifrices, and cosmetics.
15. How a metropolitan city disposes of its wastes.
16. Photography as a science and a hobby.

PART IV

17. Alchemy—old and new.
18. Science and philosophy.

Parts I and II constitute the work of the eleventh grade, the remaining parts the work of the twelfth grade. These particular units are the ones that we are using this year and they seem to satisfy most of our demands, but the list is not a fixed one and is always subject to change. The unit on photography in the twelfth grade was not in the original list but was added upon request of the group as a whole.

These particular units were chosen for several reasons. They represent major areas in which science has been applied; they are sufficiently simple that they can be studied in considerable detail without getting out of the depth of the average student; they include, in as large a measure as is desirable, much of the traditional type of science materials; they represent familiar, everyday experiences of the children; they are essentially interesting to the children; and, finally, they all afford great possibilities of student activity—things for the student himself to do. In Chicago we are particularly fortunate also in that there are many opportunities for worth-while field trips and excursions in connection with these subjects.

It is not possible to elaborate at great length upon all of the units listed, but it might be profitable to describe in some detail the work of one or two of the units and to indicate the way in which they were organized, the sort of activity which was carried out, and the nature of the materials which were used in connection with the study.

One of the most interesting of the units in the eleventh grade was that on the electric refrigerator. In Part I the skeleton, at least, of the kinetic molecular theory had already been set up and the refrigerator had been mentioned then as an excellent example of the significance of that theory and how its basic assumptions were utilized. An old refrigerator was purchased for $12.00 and the mechanism removed from the cabinet, for which we had no room. The children did considerable reading in a miscellaneous collection of science textbooks, popular books on science, advertising booklets, and such books as may be described by the phrases "how to make it" and "how it works." Simple experiments in evaporation of liquids of various degrees of volatility were carried on and the significance of the observations discussed. A tank of liquid carbon dioxide was available and it afforded sufficiently rapid evaporation to provide an excellent illustration of the relation between evaporation and temperature. The refrigerator mechanism was then attacked and after all of the sulphur dioxide gas had been allowed

to escape (the mechanism having been taken out of the building for this purpose) the various lines were disconnected and the whole thing disassembled. Careful diagrams were made at each stage of the process. The various units of the refrigerator were washed in kerosene, cleaned, and dried. Further diagrams were made of each unit and notes taken as to its operation and function. Schematic diagrams were also made of the whole assembly as a method of illustrating the way in which the refrigerator worked. The boys who cleaned out the condenser remarked at its similarity to an automobile radiator and that led to an open discussion of the function of each and the way in which each fulfilled that function. There was also a great deal of surprise as to the amount of dirt, dust, and lint which had collected in the condenser and speculation as to how it got there or why it was there.

This group had already finished the unit on the automobile and were struck with the similarity between the compressor of the refrigerator and the engine of the auto. Essential differences in the type and operation of the valves were discovered; someone remarked that the auto made use of compressed gases to produce power while in this case power was used to compress the gas. Many such little observations were made and afforded much fine material for individual and group thinking and discussion.

When all parts of the mechanism had been cleaned, studied, and individually assembled, they were then connected to each other in the proper fashion and a fresh supply of sulphur dioxide fed into the system. No particular care had been taken to remove any possible water vapor from the connecting lines or from the condenser or liquid tank and as a result considerable difficulty was experienced by ice forming on the needle of the expansion valve. This problem had to be considered, the difficulty diagnosed, and a method of remedying the condition decided upon. The problem was finally solved by pumping most of the gas into the liquid chamber, bleeding the rest of the system, and then flushing the whole thing out with carbon dioxide from the large tank of the gas which we had in the laboratory. When this had been accomplished the refrigerator worked splendidly and we were able to watch the frost forming on the expansion coil, to see it grow thicker and heavier and, finally, after about twenty-four hours of running, to find a heavy coat of ice on it.

The group wished to make some use of the machine after they had finally succeeded in getting it to work, and decided that they would like to make some ice cream. Two of the girls took care of the preparation of the ice cream mixture, using cream, milk, and an ice cream powder. A problem arose, however, as to how to insulate the freezing chamber as we had disposed of the large box in which it would normally be housed; this was taken care of by using a dozen or so Turkish towels from the locker room with which to wrap the expansion coil and thus to prevent any excessive amount of heat reaching it. The cream was in the freezing tray by about ten o'clock in the morning and when school was over in the afternoon it was ready for consumption—and the students were ready for the consuming process.

Through the study of this unit we felt that our students learned a great deal about the molecular theory of matter and how important such a theory can be in terms of practical everyday conditions; they developed an intelligent attitude toward mechanical refrigeration in general which will be of real value to them when they themselves may be faced with the necessity of purchasing a refrigerator. They enjoyed the work in connection with the unit and were particularly appreciative of the opportunity to handle the thing itself, to take it apart and actually to see how it operated; they learned things which made certain phases of life more meaningful to

them and as a consequence made life as a whole a little more enjoyable. Numerous other benefits also accrued which there is not space to mention, but such subjects as insulation, convection, the nature of heat and how it is measured, plus a great many more, came naturally into the discussion and the study. Coming as a natural outgrowth of the main problem being attacked, these corollary matters had significance and meaning—they were necessary and important and as a result were studied. Treated as isolated problems pulled out of the ether or met with in a systematic journey through a textbook, they would not have had half the appeal or presented half the challenge or contributed half so much as they did.

At the end of this unit some time was spent in the discussion of the immense social and economic significance of the development of mechanical refrigeration—how each of us, both individually and collectively, benefited from its widespread use.

In the twelfth grade the unit on "How we use some of our natural resources for producing light, heat, and mechanical energy" narrowed itself down to a concentrated study of coal and petroleum. In this unit the geology of the coal and the petroleum deposits were studied, the basic chemistry of combustion and oxidation included; there were some short excursions into the field of organic chemistry, and then the group exploded a bomb in its own midst when it began a consideration of the problem of government ownership or of government control of natural resources. Debate was vigorous, almost violent, and many were the arguments marshalled by each side. Of course, the matter was neither agreed upon by all nor in any way settled, but the thinking of the group was challenged and those who had before given the matter no serious thought began to ponder the question. Those already possessed of blind prejudices (there were such on both sides) began to see new angles and all were forced to study the problem in order either to bolster up their beliefs or to get data upon which to form a judgment.

In connection with this unit the group took an excursion to a large research laboratory where many of the major processes used in the petroleum refining industry today were developed. This particular laboratory exists by licensing to refineries their developments upon a royalty basis. This precipitated further animated discussion about the question of industry capitalizing the discoveries of research workers. The contrast between the practice of those who do research in medicine and bacteriology and of those who make discoveries in industrial technology was brought up. The proposition that research should be subsidized by the government and its fruits given freely to the people was brought forward and debated with much fervor and zeal.

There is no necessity to draw a sharp line and to say that on one side of the line there is a sort of knowledge which may be called science while on the other side of the line the knowledge, whatever it may be, is not science—for that we are prepared to admit. We will go further and admit that discussions of government control of natural resources cannot by any magic be converted to a study of the science of combustion, of the geology of petroleum, or of the nice matters of processing either of these two substances. We will not admit, however, that for the high school student the two aspects of natural resources may not be closely related. What more appropriate time to discuss such an important topic as government control of one of man's greatest heritages than when the group is interested in the way in which man converts that heritage to his own use? If one has a blind allegiance to his subject matter he will resent giving the time of that subject to such "unrelated" discussion, but if one is interested in providing for the chil-

dren in his charge the best possible educational experiences he will welcome the opportunity to set young people thinking about so vital an issue. The child's desire for knowledge and for growth is not so effectively compartmentalized as is the usual secondary school curriculum, and his enthusiasm and his interest perceive a unity among the various angles and aspects of a broad topic which all too often escapes the eye of the teacher.

Anticipating a possible charge that the sort of thing suggested in this paper is all right in its way, perhaps, but that it is not science and does not offer a satisfactory background for advanced work in science during college, we should like to point out that in the past the traditionally organized high school science has done little more for the average youngster than to kill his interest in and thus block his acquaintance with science. Taught as an abstract subject, dealing with materials largely foreign to the everyday life of the student, chemistry and physics have secured the reputation of being very difficult subjects. Many who would have profited from an acquaintanceship with the science of everyday life and who would have thoroughly enjoyed that acquaintanceship fear to take the courses lest they not do well in them and thus lower their general standings and impair their academic reputations. Other less timid souls take the courses but find so little that has any significance for them that they make their first contact with formal science their last. From the college point of view this is a highly desirable situation as it means that only the resolute, the determined, and the able ever enter the science laboratories of their respective institutions; examined in the light of the welfare of the child, however, this is a most unfortunate condition.

We feel very keenly that the primary responsibility of the secondary school is not to the college nor solely to those students going to college; nor is its primary responsibility to prepare specific children for specific courses in college; rather is its primary obligation to all young people—it is a general and not a particular obligation. To best develop the whole child in terms of his relationships to all of life is the main task of the secondary school.

If it is essential that a group of people shall specialize in any one field, and we immediately grant the validity of that premise, then it is up to the college to provide the formally organized science and the strict science disciplines for those of its number who wish them. Let us in the high school, however, be free to help the child in his efforts to know and to interpret the world in which he lives; let us have the liberty to make that science which is bound up with his everyday living meaningful and enjoyable, a rich, satisfying, vital experience long to be remembered—to be remembered, in fact, long after his colleagues of the traditional school have memorized and forgotten that "$S=\frac{1}{2}\ gt^2$."

TEACHING PUPILS THE METHOD FOR SOLVING PROBLEMS

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A society that fosters a democracy will find it advantageous to have its members participate in its plans for social betterment. To understand the purposes and to participate actively in social planning, each individual must know how to meet the problems that arise in a dynamic society and how to solve them in a scientific way. Since this method is inherent in scientific learning, science education must assume some responsibility for developing the ability of problem solving in individuals.

What can science instruction do to help boys and girls share the responsibility for social planning? In the first place, the classroom must be a democratic one in which the student is concerned with promoting the interests of the group, aiding others in adjusting themselves, making proper adjustments to the group himself, coöperating in various group enterprises, planning the learning for himself and aiding others to do the same. Freedom in the classroom is the rule rather than the exception. Here is the place where the individual is allowed and encouraged to develop his interests and capacities. Teaching will begin with the needs and interests of students, with pupil selected problems and with pupil planned units of learning. This demands a new teacher rôle. The teacher working in this type of classroom must know the instructional techniques for developing attitudes and for teaching problem solving. He must know how to teach students to plan their work and to evaluate their learning. The teacher who selects problems and presents them to students merely by writing them on the blackboard or who hands out units of instruction planned long beforehand will never develop in students the insight and ability to solve problems. Most of the formal teaching in a democratic type of classroom concerns itself with the techniques for promoting self-learning.

If the individual is to take part in the planning of his social destiny and if he is to become an independent thinker, he should be allowed and encouraged to do his own planning for the solution of the problems that originate with him. The individual must be taught the specific techniques for performing this task because they cannot be realized incidentally. Self-planning of units of learning and the execution of these plans probably do more to establish the techniques of the scientific method than does any other learning procedure.

The techniques of problem solving cannot be developed with students in any one year of school. Growth in this demands gradual and continuous learning. If these techniques have not been introduced to the student before he enters the secondary school, definite training must be given at that time. The technique should be used continuously throughout the school experiences of the individual. In the first years of the secondary school, much time should be devoted to the critical evaluation of the various sources from which information can be obtained and of the statements, opinions, and conclu-

sions made by others. Also, the student may be taught to see simple problems, to state them correctly, and to plan suitable techniques for solving them. During the third and fourth years the student can be taught how to see relationships between ideas, how to express these relationships, and how to verify his conclusions. He can be taught how to organize a whole unit of learning in terms of definite learning activities. Many students at this level will need close teacher guidance, although some can progress with a minimum of supervision because they have developed the ability to direct themselves. During the last few years of the secondary school, students should be practically independent in their pursuit of knowledge. This is possible if the techniques involved in problem solving have previously been developed with the individuals.

The students as well as the teacher must be conscious of the steps of problem solving. Direct effort must be made to develop this consciousness in planning their units. The steps to be realized in unitive planning are as follows:

1. Recognizing and formulating the unit problem.
2. Analyzing the unit problem into subordinate problems.
3. Gathering data for each of the subordinate problems.
4. Analyzing and synthesizing the data gathered for each of the subordinate problems.
5. Formulating a tentative conclusion for each.
6. Verifying the tentative conclusion for each.
7. Stating a final conclusion for each.
8. Formulating a conclusion to the unit problem, based upon the conclusions developed for each of the subordinate problems.
9. Applying the conclusion to concrete situations.

Before a student can plan a unit of learning, he must select a problem which is challenging and interesting to him so that it motivates his learning. Students vary in their ability to recognize problems. Some see and state problems readily and others require the teacher's help in analyzing their ideas into significant problematic situations. When this inability is apparent, it becomes necessary for the teacher to keep the group together for the formulation of a problem through a developmental discussion technique. To aid pupils in recognizing problems, certain teaching procedures are desirable. The teacher should first analyze the problems selected for development into situations and incidents that are familiar to the students. These situations should then be presented in logical order so that the students may see a relationship between them. When the discussion has resulted in making this relationship evident, the learner should be given the opportunity to formulate the relationship into a problem. The problem should be a clear and concise interrogation of one important idea. This idea must be one that contains a broad and comprehensive relationship and one that is challenging to the student.

If the problem survives this evaluation, it becomes the unit problem. This must then be analyzed into the minor concepts that are involved in it. These become the basis for the formulation of subsidiary problems. These latter problems should satisfy the standards used for evaluating the unit problem. In addition, each one should involve one important phase of the unit. All of the problems should be arranged in an order that will logically develop a solution to the unit problem. The next step in the learning process is the determination of activities and the teaching of the techniques that may be employed in obtaining data for the solution of the problems. The following are possible learning activities:

1. Experimentation, using original methods whenever possible.
2. Making original investigations of community problems.

3. Taking trips to observe processes, devices, and natural phenomena.
4. Interviewing authorities and individuals who have had experience with the problem.
5. Observing demonstrations, films, slides, and charts.
6. Locating reference material in various books, magazines, newspapers, and bulletins.
7. Using panel discussions.

Since students vary in their methods of learning, they should be encouraged to select the activities in which they are most interested, which they are capable of performing, and which are most desirable for obtaining information pertinent to the problem. After the methods have been selected, the student should evaluate them. He should decide whether he has planned to obtain information from different sources in order to gain sufficient understanding, whether the sources are reliable, and whether the data obtained therefrom pertain to the problem. He should also attempt to get as much first-hand information as possible. The plan, in order to guide the learner in gathering data, should be definite and complete. If the student plans to interview someone, he should state whom he plans to interview; if he plans to read, he should include his bibliography; and if he plans to experiment, he should formulate his procedures.

Careful and detailed planning should be made for all subsequent steps of problem solving, such as analyzing the data, arriving at conclusions, testing the conclusion, and applying what is learned. In this way the student is learning techniques for planning, for gaining insight, for developing initiative and the ability to direct himself. In short, he is performing the activities that have long been done for him by the teacher.

The student executes his unit plan and records his data under the guidance of the teacher. Definite learning techniques for each step in problem solving is taught each time the student faces this need. As the individual gathers the data, he is taught to organize the information in paragraph form, in outline form, in a table or a graph. Next, he analyzes the data for important ideas and formulates them into more comprehensive ideas. These latter statements should be further summarized into one or more comprehensive generalizations or tentative conclusions. The processes of selecting important ideas and associating them into larger and more comprehensive meanings are difficult ones for the learner. Certain techniques, if used by the student, are very useful to him in performing these two steps of problem solving. In order to aid him in selecting important ideas, he may be directed to summarize what he has learned from each of the experiments, from reading, and from the interviews. To formulate these smaller ideas into more comprehensive meanings, the student must recognize the main concepts in the sentences and then be guided to see relationships. This involves the process of generalizing and is the method whereby tentative conclusions or generalizations are made. To facilitate this process of generalizing, one of the three following methods is ordinarily used, namely, noting similarities, dissimilarities, and accompanying changes. Older students may be taught the methods so that these can be used intelligently in recognizing relationships in the assembled information.

The learner must be taught that conclusions should be made on the basis of the available data, only on defensible information, and that they must be verified for accuracy. This can be done by securing additional information, by applying the conclusion to concrete situations, by interviewing an authority, by reading other authoritative books, or by experimenting with materials. The student should continue to search for evidence until he is convinced that he has developed a solution to his problem as nearly correct as the evidence permits.

He must be willing to change his conclusion if later evidence shows that the first one is wrong. When the tentative conclusion has been verified, it becomes the final conclusion to the problem. In order that it may have meaning to the student, he must apply it to his experiences. This application is vital if his behavior is to be affected.

From the foregoing discussion it is shown that the scientific attitudes are the criteria for evaluating learning. These must be taught and learned concomitantly with each step of problem solving. The teacher takes a prominent place in this learning plan because these attitudes, viewpoints, or standards for evaluating learning must be taught when needed and taught over and over again. Boys and girls must be made conscious of the attitudes and each one must be recognized as a part of the technique to be employed in solving problems. Each attitude is an integral part and no problem is solved adequately without the use of such an evaluating procedure.

A student may understand the steps of problem solving and be conscious of worthwhile criteria, standards, or viewpoints for evaluating his learning; but before he can solve problems adequately he must possess certain basic skills. These are the skills of reading, writing, speaking, and of organizing data. The student must be able to use the library facilities and the parts of a book so that he may locate source materials. He must be able to comprehend what he reads and to interpret graphic materials. He must be able to use bulletins, newspapers, apparatus, handbooks, encyclopedias, films, and slides to obtain information. He must be capable of planning the details of an experiment so that one variable is present, proper controls are utilized, and qualitative and quantative data are recorded. He must be able to interpret formulæ and perform the fundamental mathematical operations necessary to solve his problems satisfactorily. He must use correct and effective means for presenting the data orally and must develop his ability in written expression to record his information effectively.

These skills may be identified in the various steps as the student follows through the problem solving procedure. Unless the student can use these skills, he is handicapped in making progress under his own power. The teacher must be able to identify these skills and to direct their development when they are needed in the problem solving process. He must also be able to determine when the student lacks these skills or is using them ineffectively. It is possible to determine these deficiencies by means of tests, but the most effective determination is made in real situations where the student is actually using or attempting to use the skills.

Drill should be directed toward the development of these skills. It is more effective if the materials used for this purpose are those materials upon which the individual was working when his trouble was discovered. Here, for example, the English and mathematics teachers may realize and effectively teach their respective fundamental skills. If it is not possible for them to come into the class where the difficulties are encountered, they may assist the teacher in charge of the class in developing proper drill techniques for the skills needed.

These basic skills are the tools the individual uses in solving his problems. His attitudes determine how effectively he will use them in solving his problems. Skills, attitudes, and the steps of problem solving become identified with each other. It is impossible for one to develop without the concomitant development of the other. In each step of problem solving appropriate skills, techniques, and attitudes should function if learning is to be unified.

SCIENCE AS A PART OF LIVING IN THE ELEMENTARY SCHOOL

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Before a discussion of science in the lower school can be considered, there is need to direct our attention to the entire elementary school, its philosophy, its plans and purposes, for only in the light of the philosophy for the elementary school as a dynamic whole can any area of experiences or learning be evaluated. Any experience, whether it be concerned with writing an original story or experimenting with magnets or planning a large unit of work, finds its merit in the extent to which it is an integral part of the whole plan for development of growing boys and girls as is set forth in the philosophy of the whole undertaking of the elementary school.

The discussion of philosophy here might apply to many elementary schools, but for purpose of concrete illustration the University Elementary School of the Ohio State University is used. For a more adequate and complete presentation of the point of view of the school "The Program," *The Record of the University School,*[1] will be helpful. The implications for science in light of the point of view expressed are being increasingly recognized and amplified in the school, but they are by no means an accomplished and well-established part of the program. The presentation that follows is an indication of the trend this development is taking.

The educational direction and spirit of the school are apparent in the following discussion:

> The philosophy of our University School places a great deal of emphasis upon the integration of the school experience of the individual student so that he develops a sensitivity and an effective life with the interrelationship of all its factors. . . . Perhaps nothing more indicative of the philosophy of the school can be said than that each individual member of the school community is, himself, seen entire. The whole child is educated to physical, mental, personal healthfulness through a teacher-pupil relationship of confidence and intimacy, based upon interest in the child not only in school but outside of school and in the home, and assisted by a most thoughtful study of his emotional and social adjustments to his appropriate group.[2]

This clearly implies a rich and living school community; it means opportunity for participation in activities that are real to the child and pertinent to his needs as a growing individual; and it necessitates actual planning, experimentation, evaluation on the part of each child for continuous growth.

In such a community, writes Dr. Boyd Bode,

> The central emphasis falls on the "continuous reconstruction of experience," which is opposed to all forms of compartmentalization or regimentation. This reconstruction of experience, if it is to have any significance, must take the form of actual living and doing. Consequently the school must be transformed into a place where pupils go, not primarily to acquire knowledge, but to carry on a way of life. That is, the school is to be regarded as, first of all, an ideal community in which

[1] "The Program," *The Record of the University School,* Ohio State University, Columbus, Vol. II, No. 1, April, 1936, pp. 11-30.
[2] *Ibid,* pp. 7-8.

> pupils get practice in coöperation, in self-government, and in the application of intelligence to difficulties or problems as they may arise. In such a community there is no antecedent compartmentalization of values. Shopwork, for example, is not dominated by the idea of personal profit, but becomes a medium for the expression of esthetic values and social aims. The quest for knowledge is not ruled by the standards of research, but is brought into immediate relation with human ends. Judgments of conduct are not based on abstract rules, but on considerations of group welfare. Hence it can be maintained with some plausibility that in a school of this kind we are actually engaged in developing a generalized pattern of conduct or a way of life.[3]

A further statement by Dr. Bode points out an additional responsibility of this school community:

> . . . the school environment must be so set up that the way of life cultivated in the school will be maintained and extended when the pupils pass on from the school environment to the larger social environment outside of the school. Here we strike the difficulty that the school environment is, of necessity, more or less isolated from the larger environment.[4]

An elementary school living and breathing such a philosophy is characterized by large activities selected and evaluated by the teacher and the children on the basis of the opportunities therein for the development of leadership, the need for the division of labor and for independence, for real participation in the basic functions of living. These large activities are often spoken of as units, especially in the upper grades. In the kindergarten the large activity might be a trip which would take one morning or the planting of seeds which would involve a much longer time span. Further consideration is given to selection of the large activity so that it will be one within which children find the need to develop the ability to obtain information from other sources as well as from reading, to develop a dependable attitude toward their responsibilities, to develop creativeness, perseverance, the habit of reaching conclusions on the basis of valid evidence, to develop reading ability, to develop standards of accomplishment. The University School has no fixed curriculum of activities or units. The faculty with the help of the children evaluate by means of their own defined criteria all proposed large activities before definitely deciding which to pursue.

A philosophy of education as summarized briefly in the previous paragraphs implies certain needs and interests to which science experiences and materials have a special contribution to make. In these large well-balanced units of activities many problems are recognized concerning how things work, why certain conditions in the environment exist, how people live and grow, how man makes use of machines. Science experiences find an opportunity and a responsibility to the whole development of the child by assisting him in the recognition of these problems as part of the larger activity at hand, in the attempt to solve the problems experimentally through the selection and use of materials, in the discovery of how things work by actually working with the materials to reveal the principles involved, in the recognition of the applications of these ideas or principles to similar happenings in the environment.

These science experiences have a special responsibility to contribute to the following developments: (1) an increasing and widening understanding of the environment in terms of how things work and how to do things; (2) the growth of naïve curiosity about the "how and why" of things into a deeper intellectual curiosity; (3) the ability to apply principles and generalizations discovered in one situation to new situations;

[3] Bode, Boyd H., "The Confusion in Present Day Education." Chapter I in *The Educational Frontier*, edited by William H. Kilpatrick. D. Appleton-Century Company, 1933, pp. 19-20.
[4] *Ibid*, p. 20.

(4) the ability to define problems; (5) growth in the interest and faith of the individual in his own ability to solve problems; (6) the ability to choose materials through the use of which problems can be solved; (7) skill in making careful observations; (8) ability to draw inferences from data. These developments necessitate much experience in working with real materials in a dynamic way. It is one thing to find out by reading that magnets attract iron and steel; it is quite another for a child to come to that understanding through having recognized the need to know what magnets will pick up in connection with some larger problem at hand, by deciding just what could be tried out to get the solution, by selecting materials needed for the experiment, by actually trying to pick up with the magnet the materials selected, and by coming to a conclusion about the question in light of his observations. The science experiences should be such that the children are not dominated by subject matter but are encouraged to form strong habits of first-hand research and to use what they find.

How these science experiences arise and how they are developed are both implied in the discussion of the general point of view. The source of all the problems, whether they pertain to science, reading, art, or any other aspect of learning, is the larger problem which binds the larger activity together. All problems that arise in this major undertaking and all materials needed for the solution of these problems are important and pertinent, regardless of how they might be classified—as art, science, reading, arithmetic.

This can be shown more clearly by illustration. A third grade had set up as their large activity a study of travel. Along with a great many other needs, the following problems which can be called "science problems" arose: "How does a balloon get up into the air?" "How high will a balloon go?" "How can a balloon be brought back to earth?" "Why are gases used in balloons?" "Which gases are best?" Similar problems regarding the operation of airplanes, steam engines, gas engines, and motors arose as the children progressed with their study of travel.

Here we find these problems arising as genuine needs and interests as a part of a larger problem. The children are recognizing and defining the problems they need to solve in their community undertaking. Here, indeed, is opposition to "all forms of compartmentalization." This approach is in direct opposition to isolation of areas of experiences, an isolation illustrated by the methods that are frequently used in many elementary schools in the consideration of communication. For example, in some schools the history of the development of communication is considered in the social studies. Great emphasis is placed upon the changes brought about in the social order as a result of the improvements in means of communication without allowing or encouraging an experience that would lead to the discovery of the scientific principles involved in some of the instruments of communication, the use and control of which has so definitely influenced our society. Set quite apart from this consideration in the social studies will be a science class devoted to the understanding of sound waves, the transformation of sound waves into electrical energy and back into sound waves, as exemplified by the telegraph, telephone, and the radio. Here much attention is given to the development of scientific principles involved, but little to the implications for the use and the control of these principles in the social order. The very nature of such a divorcement of the two fundamental aspects of a problem is to make for isolation of the school from life.

John Dewey, in speaking of the isolation of the school from life, says:

> Again in this matter of isolation of school material from life versus that connection

> with it which would give the only kind of understanding of social forces that will prepare students to take an intelligent part in the maintenance and growing development of democracy, I ask: "How far is science taught in relation to its social consequences, actual and possible, if the resources which science puts at human disposal were utilized for general democratic social welfare?" I know that very great improvements are being made, but I am afraid that science is still taught very largely as a separate and isolated subject and that there are still those, including many scientists themselves, who would think that that wonderful thing "pure" science would be contaminated if it were brought into connection with social practice. And yet without this connection, students are certainly getting very little intelligent understanding of the forces that are now making human society and that might remake it. . . . The people who are active in the direction of public affairs lack prevision because they have no understanding of the scientific technological forces that are actually shaping society. The education of the average scientist and the average technician, on the other hand, is such that he is left indifferent to the social consequences of his own activities. Hence, it is nobody's business to take stock of the resources of knowledge now available for social betterment.[5]

What responsibility does our philosophy place upon us as to the manner of solution of these problems that have been defined in the large activity? Is it not imperative that children share the responsibility for selecting the materials through which the problems can be solved? The teacher has a responsibility for helping the children to have real experiences from which they may derive the ideas needed in answering their own questions.

In discovering the ideas involved in the questions, for example, those concerning the balloons which were mentioned previously, experiences with the following facts are necessary: air takes up space, air has weight, air pushes from all sides, some gases are lighter than air, some light gases are dangerous because they explode. Simple experiments involving each idea are worked out by the children and the teacher coöperatively. There is no mere telling that air takes up space, that it pushes from all sides, but real discovery is made by the children as they, with the guidance of the teacher, use glasses, milk bottles, corks, water, and varnish cans. In such experiences, in a manner very elementary and slow but none the less fundamental and genuine, the child has opportunities to choose materials through the use of which problems can be solved, to make careful observations, to draw inferences from data, to apply principles and generalizations discovered in one situation to new situations. At any time that a child through several experiences with materials synthesizes from his experiences a relationship or underlying principle that is new to him, he is having a creative and integrating experience, and he is building up faith in his own ability to discover meanings. Even if this principle has been known by the race for a long time, for the child it has not existed before, and now through his own experimentation he has come to a new understanding.

> The distinction between knowledge, information, and understanding is not a complicated or philosophical matter. An individual may know all about the structure of an automobile, may be able to name all the parts of the machine and tell what they are there for. But he does not understand the machine unless he knows how it works and how to work it; and, if it doesn't work right, what to do in order to *make* it work right. You can carry that simple illustration through any field that you please.
>
> Understanding has to be in terms of how things work and how to do things. Understanding, by its very nature, is related to action; just as knowledge, by its very nature, is isolated from action or connected with it only here and there by accident.[6]

[5] Dewey, John, "The Challenge of Democracy to Education." *Progressive Education*, Vol. XIV, No. 2, February, 1937, pp. 82-83 and 84.
[6] Dewey, John, *Ibid*, p. 81.

To provide opportunity for children to come to understandings by means of their own experimentation and thereby discover how and why things work as they do, a science workshop is needed to supplement the regular classroom. The University Elementary School is developing such a workshop. The responsibilities of the science experiences presented in the foregoing paragraphs also indicate certain requirements for the science workshop. Here flexibility of room and equipment is paramount. A rigid, formal, and expensively equipped science room patterned after the traditional academic science laboratories would handicap the creative science experiences. The science workshop is not a science room or laboratory narrowly conceived. Space is needed for many experiments to go on at the same time. There needs to be room to grow plants, to keep pets, to set up aquaria and terraria. A work bench with hammers, saws, drills, and screwdrivers will enrich the opportunities for real experimentation. Water, gas, and electrical outlets are indispensable.

The equipment needs to be such as can be freely handled by children when they select the materials to be used, set the experiments, and observe the happenings. Among many articles that children can contribute are milk bottles, tin cans, string, old dry cells, etc.

If children are to recognize the operation of the simple principles they discover here as operative in the common phenomena with which they live apart from the workshop, the equipment must be characteristic of their whole environment. Defining problems, selecting materials, experimenting, observing, drawing conclusions, sharing ideas, caring for equipment, planning together and individually are activities that would characterize the ideal functioning of this room. These activities, however, are not peculiar to the science room alone.

The successes or failures of the trends of development in this science program must be evaluated in terms of growth on the part of the children in those aspects of living which have been set forth as fundamental and significant in the aims and purposes of the whole school. This evaluation needs to be carefully and scientifically set up so that the program can be modified, expanded, amplified, or discarded in the light of evidence of desirable growth or the lack of it on the part of the children and not in terms of wishful thinking. The philosophy brings inspiration to the development and points the direction in terms of objectives, but any claims for growth in the attainment of these objectives must be supported by evidence that is valid.

EVALUATION IN ELEMENTARY SCHOOL SCIENCE

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In preparing an evaluation device, it has been customary to make an analysis of the content of the course and to select various materials from that content which seemed appropriate for test items. The materials were arranged in several types of test items, such as true-false, multiple choice, matching, completion, and so on. In this procedure of evaluation, attention is directed toward course content and seldom toward the changes in pupil behavior which the course content and experiences are designed to bring about. Studies of the results obtained from many tests built in this fashion reveal that almost the only type of pupil behavior of which they give evidence is that of the recall of information. The acquisition of information has become the principle objective measured by the usual school tests. Teachers have other objectives which they expect pupils to be achieving. Evidence of the amount of information acquired is not necessarily satisfactory evidence of the degree to which pupils are reaching other equally important objectives. Some pupils with good memories may easily acquire a relatively large amount of information but may be able to do very little independent thinking with this information.

Another factor which has influenced the use of information tests, almost to the exclusion of tests for other objectives, is the desire for tests which are practicable. Practicability has often been considered as the most important characteristic of a test. That is to say, if a particular type of test is easy to prepare, easy to administer, and easy to score, that type of test is often used to the exclusion of other procedures for getting other equally important evidence of growth. Under usual teaching conditions practicability certainly is an important characteristic to consider in selecting a test. A teacher's time is valuable, and a device which will provide economically the necessary evidence of a pupil's development is of greater value than one which does not do so, other things being equal. Unfortunately, however, other things are not usually equal; and practicability is, therefore, often purchased at the expense of other important characteristics. For example, validity, in the sense of the kind of behavior, is frequently sacrificed when practicability is made the only criterion for test selection.

It is not the purpose of this introduction to minimize the importance of practicability in school tests. A test which is economical of time and energy should receive favorable consideration. Nevertheless, practicability should not rank first in importance. Unless teachers are able to get valid evidence of growth by means of the test used, practicability is of no value. Evidence of growth in height is economical to obtain, but it is not valid evidence of growth in aspects of mental or social development. A test may give evidence of the amount of science information elementary school children have acquired, but it may not give valid evidence of the degree to which they can think for themselves nor of their attitudes toward "truth" or other scientific attitudes. A different kind of evidence and a different technique for collecting that evidence is probably necessary in the

case of each of these different types of objectives. For some objectives a paper-and-pencil test may be used to collect the kind of evidence desired; for other objectives it may be necessary to observe the pupil and record his behavior; for still other objectives the product, such as a piece of apparatus or a drawing made, may be evaluated with reference to each of the important characteristics of such products. In this manner evaluation is used in its broad sense, meaning the collection and interpretation of any sort of valid evidence of physical, mental, emotional, or social behavior.

In some quarters, teachers have realized that information tests do not give satisfactory evidence of various other aspects of pupil growth which elementary science teaching is designed to encourage. Many of these aspects of growth are highly "intangible." Procedures of evaluation for most of these "intangible" objectives are not available. In the absence of appropriate methods, evaluations are often made in terms of the experiences provided children rather than in terms of the effects of these experiences on pupil behavior. That is to say, sometimes teachers describe the science experiences provided and teaching procedures used, with the hope that the desired changes in behavior are taking place in pupils. In such cases it is assumed that the pupils' experiences are bringing about the desired effects. The science experiences and teaching procedures are still in the realm of good hypotheses and there remains the question of whether the desired effects are really obtained when these experiences are provided. It is conceivable that some effects cannot be observed in the behavior of pupils immediately after the experience and that the expression of these effects does not occur until a later time. But it is also conceivable that *some* evidence of change in pupils can be obtained almost immediately. If so, the changes which can reasonably be expected need to be clarified and made concrete so that both pupils and teachers can identify them in noting progress.

When present practices of evaluation are checked against a background of the purposes of teaching, it is clear that methods of evaluation need to be improved. Four major steps are helpful in improving an evaluation program. They are: first, formulating the objectives of teaching; second, clarifying the objectives by expressing their meaning in terms of pupil behavior; third, getting a record of that behavior; and fourth, interpreting the behavior.

Two methods[1] have been found useful in formulating the objectives to be included in a more comprehensive evaluation program. As applied to the purposes of the elementary school, the first method would be to consider the general purposes of science experiences for elementary school boys and girls and to analyze these purposes into their subsidiary purposes by asking: What should these science experiences do to boys and girls? What contributions should they make to the lives of these pupils? When this procedure is used, various important changes are identified. A second method is helpful in checking the relative completeness of the list of objectives. By this method the teaching procedures and course content are examined. As each topic of the course is considered, questions such as the following can be raised: Why was this topic included in the course? What change should it bring about in pupils? The second method supplements the first. Some objectives not listed by the first method are brought out by the second. These two methods are helpful in the absence of searching curriculum studies founded on the needs of elementary school pupils.

Teachers interested in science teaching in the elementary school have stated several objectives — changes which science teaching should help bring about in elementary school

[1] Tyler, Ralph W., "Formulating Objectives for Tests." *Educational Research Bulletin (Ohio State University)*, 12: 197-206; October 11, 1933. (Reprinted in *Constructing Achievement Tests*, pp. 14-23, Ohio State University, 1934.)

boys and girls. Some of these objectives are: discovering and defining problems; applying principles or generalizations to new situations; developing an interest and confidence in one's own ability to solve problems; choosing materials through the use of which problems can be solved; recognizing explanations which ascribe purpose to plant processes and activities of animals; acquiring a fund of science information, skills, and habits; drawing reasonable conclusions from data; interpreting natural phenomena; and developing scientific attitudes.

A mere statement of the objectives, however, sometimes results in a sterile attempt at improving the curriculum and procedures of evaluation. The objectives often remain as nice words with little concrete meaning and do not function in pointing the direction in which learning is to take place. Objectives need to be clarified and stated concretely in terms of what pupils can be expected to do. What can elementary school pupils be expected to do which shows that they are learning to discover and define problems, to apply science principles in solving problems new to them, to chose materials by which problems can be solved, to recognize teleological explanations of natural phenomena, to draw reasonable conclusions from data? What can elementary school pupils be expected to do which shows that they are developing an interest and confidence in their own ability to solve problems, that they are developing scientific attitudes, or that they are acquiring science information, skills, and habits?

The ability to discover and define problems may be expressed in the kinds of questions children formulate and ask. For example, a group of children in the third grade, while reading and discussing various modes of travel, formulated and raised questions like these: "How does an airplane get off the ground?" "Are there some experiments we can do in solving this problem?" "How does steam make a steam engine work?" "How does a gasoline engine get its power?" Kindergarten children asked: "Where does the sun go when it goes down?" Second grade children who were making a study of fire prevention defined the following problems and asked for help in experimenting to solve them: "How can fires be put out?" "How does a fire extinguisher work?" Science teachers in the elementary school at the Ohio State University School have many illustrations like these. This behavior is not only evidence of the ability to formulate and define problems, but it is also evidence that pupils are achieving other objectives of science teaching. It is evidence of an interest and confidence in their own ability to solve problems which perhaps is closely related to the attitude that they can do something about solving their problems and need not depend upon an unintelligent acceptance of authority. These illustrations constitute a clarification of an objective in concrete behavior of children. Each objective must be made more meaningful, so that expressions of the objective can be observed and recorded.

A third problem in improving an evaluation program is that of getting a record of behavior. This is important so that the behavior can be judged at a later time in light of subsequent behavior. An observer's memory is notably unreliable, being influenced by the most recent behavior and perhaps by only one seemingly important instance. A record also makes it possible for others to evaluate the evidence, thereby reducing the effect of individual bias.

A paper-and-pencil test is the type of record commonly used; here the pupil makes the record himself. A paper-and-pencil test is not a satisfactory procedure for some objectives, chiefly because no tests have been invented on which the pupil can demonstrate the type of behavior which directly expresses the objective, and because the be-

havior required on the test has not been adequately checked to see if it is a good index of the kind of behavior which does directly express the objective. Until satisfactory methods can be developed for getting evidence of growth in "intangible" objectives, the anecdotal record is a useful procedure. Instances in which pupils show behavior characterizing objectives can be noted and recorded by the teacher. The behavior should be described as accurately and objectively as possible with a minimum of interpretation involved. The purpose of the anecdotal record is to recall the situation and the pupils' behavior clearly. It serves as a substitute for use by other judges who were not present when the behavior occurred. The interpretation of the behavior can be made on the reverse side of the sheet or card. With a little practice, teachers develop facility in describing behavior objectively. They report that it has helped them to recognize and to be sensitive to expressions of objectives which heretofore had passed unnoticed. Parents' reports of children's out-of-school experiences and children's records of their plans for their in-school and out-of-school activities are further evidences which throw light on their development.

Interpretation of the record of behavior depends upon the purposes for which the records are made. If a composite measure of pupil achievement is desired, a single score or grade has been used. Most pupils and most teachers, however, want a more diagnostic evaluation. They want the evaluation to show the objectives in which the pupils are especially strong or especially weak so that they will have a basis for deciding upon next steps in the development of the children. For some purposes the evaluation may be made in terms of numerical scores; in other cases it may be made in terms of descriptions of behavior. For example, in studying the pupils' responses to a test on which they were asked to tell how they could test each belief, it was found that the behavior of the pupils could be described in several ways. Some pupils gave no method for testing the belief. If a belief was true to them, it was true because they thought it was true—and if they thought it was true, it *was* true. This sort of circular reasoning permitted no outside check with reality. Other pupils indicated that they would consult some authority. It appeared that they did not realize that *they* could do something to check the belief. Others said that the truth or falsity of the belief could be determined by experimentation, but gave none of the details of an experimental plan. Still others described a method for getting evidence which they could use as a basis in deciding upon the truth or falsity of the belief. These descriptive evaluations are helpful in pointing out directions in which subsequent teaching might proceed.

The development of a broader evaluation program depends upon its worth—the values which accrue from it. A brief description of some of the more important uses of an evaluation program follows:

It helps the pupil to see the interesting directions in which he can be developing. It helps him to see that his efforts may result not merely in his being "good" or "poor" in science but that he may be poor in some aspects of his development and very good in others. There is evidence to show that for some pupils this understanding of their achievement, as, for example, in making use of an idea they have discovered, is conducive to good mental health in that it brings about a sense of security and satisfaction in their accomplishment. Furthermore, the evidence of evaluation results helps to locate in an objective manner points at which there is difficulty and identifies directions in which the pupil may wisely expend his efforts. The sensation of being blocked and facing a hopeless situation may give way to a constructive perspective of what he can do,

when evaluation results are used intelligently by a teacher interested in the welfare of boys and girls. In similar manner it is helpful to the pupil in having an objective evaluation of his achievement. It probably helps to provide him with a sense of growth, even if he has not reached a very high standard.

A second use of a more diagnostic evaluation program is its value to teachers in selecting and directing the experiences provided boys and girls. Strengths and weaknesses of the class as a group may be identified. Teaching emphasis can take its cues from the evidence obtained by satisfactory methods of evaluation. If the pupils show unsatisfactory progress in an important objective, teaching procedures, materials, and educational experiences may be adopted toward removing difficulties and promoting fuller development in accordance with the individualities in the class.

Third, new teaching procedures, administrative changes, curriculum materials, and educational experiences are constantly being suggested to bring about desired outcomes in pupils. These procedures need to be evaluated with impartial evidence in order to judge their relative effectiveness. Evaluation is necessary so that not only the schools in which the changes have been tried may have sound evidence in place of hope, but also so that other schools may have evidence from which to judge the benefit of these procedures. Without adequate evidence much discussion rages over proposed procedures with unconvincing results. Adequate evidence implies techniques for getting evidence of the degree to which development has taken place.

More and more the school public is becoming interested in the effects of the school on their boys and girls. The recent financial stringency has brought to their attention the cost of education. For a time the question of whether the cost of education was too great was seriously considered. Some people wonder whether the schools are as good as they used to be. Valid evidence of the achievement of pupils in a variety of important objectives provide a basis for answering these questions.

In actual practice, the major use of evaluation has been for the purpose of giving grades. This is unfortunate. Undesirable effects upon the personalities of pupils are influencing some schools to minimize or discontinue testing for this purpose. They are encouraging pupils to want tests to appraise their own progress and are hoping to dispel the "panicky" feeling when pupils are confronted with tests. These schools are discouraging the use of a single mark of achievement. They are developing patterns of achievement consisting of changes in behavior appropriate for individual pupils. A more analytical and descriptive evaluation distributed throughout the year is being used so that evidence of growth or lack of growth may be obtained periodically, and so that helpful experiences may be provided pupils before they complete the course. In other words, they expect to do something about the results of tests before the pupils leave their classes. Many evaluations can be made during the child's experiences and one does not need to wait until the end of a six-weeks period or semester.

The uses to be made of the results of evaluation indicate that evidence of pupil growth must be obtained in a variety of objectives. Evaluation must not be limited to the amount of information acquired. Four major steps have been found useful in improving methods of evaluation: (1) formulating the objectives, (2) clarifying the objectives, (3) getting a record of pupil behavior, and (4) interpreting the record. When teachers seriously consider the problem of evaluating growth in implicit and "intangible" objectives of teaching, the objectives become clearer to both pupils and teachers.

STUDIES OF LEARNING IN SCHOOL SITUATIONS

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The time arrives in the study of every subject when laboratory findings must be applied in situations of everyday life where are present all the factors research workers went to such trouble to eliminate or control in the laboratory. In bacteriology, for example, methods for destroying typhoid bacilli which may be successfully applied to organisms living in test tubes on laboratory shelves may not be used when their abode is a human being. Dozens of uncontrolled and uncontrollable factors must be taken into account in this latter case. Similarly in education and psychology we have accumulated to date much information about learning. This has been gathered in psychological laboratories under controlled conditions or in school situations where every effort is made to minimize differences between learners and to isolate specific learning situations and specific outcomes in numerically describable form. It seems possible and desirable now to make a study of learning as it goes on in classes which are not experimental or special in any respect except in effort to apply modern educational theories.

To this end we have asked the coöperation of teachers who are professionally interested and up-to-date, who understand children so far as adults may, and who are able to select and organize teaching procedures so that children learn what is of interest and value to them. These are not paragons but the "good" teachers whom administrators and supervisors everywhere depend upon, and whom children trust and respect. Our assumption is that these teachers are effectively setting stimuli for desirable learning. What stimuli do they provide? What do their students learn and how does this learning influence thinking and acting and feeling? Answers to these questions will have value for research workers and for teachers. They will help research workers to identify specific and significant problems in need of solution; they will give teachers stimulating suggestions for enriching the work of their students.

The study reported here is being carried on under the auspices of the Bureau of Educational Research in Science.[1] Broadly speaking, the work of this Bureau is along two lines. One is the reviewing of findings in many fields of science with a view to discovering materials of greatest significance for human beings, these to be formulated as a series of generalizations. The other aspect of the work is exemplified in this study—the finding of ways by which students may be helped to explore these generalizations with the greatest benefit to themselves. Our work is limited to a consideration of learning within the field of science by students in the secondary school, the seventh through the fourteenth grade. It is being carried out with the coöperation of a number of teachers of science in New York, New Jersey, Washington, D. C., Columbus, Fort Worth, and Oakland. Close working relations have been set up with the Thayer Commission on Reorganization of Secondary School Curricula and with the Aikin Commission on Relations of Secondary Schools and Colleges.

[1] Teachers College, Columbia University, New York.

Although learning is a single process, for purposes of clarifying our thinking we may analyze it in various ways. We have chosen as a basis for analysis of learning the *kinds* of changes in students which may be facilitated through well-directed science teaching:

1. Formation and understanding of concepts.
2. Development of careful and critical methods of thinking.
3. Changes in overt behavior.
4. Development of specific attitudes, interests, and appreciations.
5. Development of an adequate and intelligent philosophy of life, of consistent and constructive attitudes toward ourselves and toward the rest of the universe.

These categories represent in large part mental functions. Hence the lines between them cannot be as clear-cut and distinct as if we were dealing with arbitrarily determined units. For example, changes in overt behavior (3), which we place here in a separate category, may involve development of concepts (1), changes in ways of thinking (2), development of attitudes and interests (4), and even changes in our understanding of ourselves and of the universe (5). Achievement in all of these categories may be and usually is simultaneous. However, each of these represents a kind of change which can be conceptualized and which we hope can be identified in the lives of students.

The problem of understanding learning in all its aspects is too broad for complete solution in a single study. Obviously, we do not at present have the necessary tools and techniques for its solution. Two methods of attack are then open to us. One is the analysis of the problem into smaller problems, attacking these piecemeal, devising the needed tools and techniques as we work. In many cases the devising and standardizing of a tool or technique constitutes a problem in itself. The objection to this method is that solution of each of these smaller problems tends to become an end in itself, obscuring their relationship as a whole. Findings from studies made in isolation from each other cannot be added together to give us a comprehensive picture of learning as a whole as it goes on in complex school situations. The preliminary analysis into subordinate problems must be made in terms of the desired synthesis and the relationship of each problem to other problems clearly set forth.

The second method involves an attack on the problems of learning as a whole, with full realization that we cannot fill in all of the details. A broad view lacking in some details is of greater value to teachers in classrooms than complete knowledge of a few details without appreciation of their significant relationships. Expressed fancifully, we might say we have enough pieces of the jigsaw puzzle to put together and get a working idea of the picture. To wait until we have all of the pieces is to set an unnecessary limit to progress.

We have chosen at present to follow this second method. We should like to give students of various ages, abilities, and backgrounds the richest kind of opportunities for experience relating to significant generalizations of science and discover what ways of thinking, acting, and feeling they would develop. As the closest practical approximation to this ideal, we have asked our coöperating teachers to report to us the experiences their students pass through and the learning attained relative to a few significant generalizations. In some cases we have made many suggestions, in others relatively few. In every case our purpose has been to find what opportunities these "good" teachers provide and what learning goes on in their classes rather than to dictate procedures.

We are asking our coöperating teachers for reports of their teaching which will show all the kinds of learning situations available to their students. We are not satisfied with

a barren list of experiments performed and pages read in textbooks, or even a list of field trips and outside speakers. What did the class discuss? To what extent did they plan their own work? What questions or comments did they bring in which brought to attention new applications of what they were learning? By what questions or comments did the teacher direct attention to significant implications for thinking and for individual and social welfare? These are additional questions to be answered if we are to get an adequate picture of the learning experiences of a group.

To get such a record of what a class does is extremely difficult although it seems obvious that no study of learning is possible without a detailed picture of the situations in which learning goes on. We must have, first of all, a description of the class itself since the effectiveness of the situation depends upon characteristics of the learners. We ask for as many of the following as teachers can provide: (1) subject being taught; (2) grade; (3) number of periods class meets per week; (4) size of class; (5) sex distribution; (6) age range, average; (7) range of intellectual levels, average; (8) future plans; (9) economic, cultural and social backgrounds; (10) any other characteristics of the class as a whole or of individuals within it which the teacher thinks significant.

The time will probably come when studies of learning in classrooms will be carried on by means of talking motion pictures, thus making available for leisurely study fleeting impressions and sequences too transitory in their occurrence for adequate understanding. We have made a few studies to date of sound transcription of specific classroom situations. Expense and technical difficulties in preserving a natural learning situation are limiting factors in this mode of recording, although these seem by no means insurmountable.

Another method of recording which we have used is that of stenographic records. Our experience has shown these to be most useful when supplemented by records made by a trained observer, who selects from a complicated situation the more significant elements, who times proceedings, identifies speakers, and records movements, gestures, and facial expressions, thus making the total situation more understandable.

Some teachers are able to give us extremely valuable accounts of what takes place in their own classrooms. This means taking notes during the class period, amplifying and supplementing these immediately after class. The teacher's knowledge of the children and of the situation as a whole makes these notes, fragmentary at best, more valuable than the most voluminous reports from less enlightened observers.

We have used score cards in a few instances to obtain records of specific kinds of responses, particularly those involving formulation of hypotheses, organization of data, and other processes involved in scientific thinking. In the hands of a trained observer these have been used to give excellent records of opportunities for critical thought arising in classroom situations and of the responses which individuals make. Development of score cards involves preliminary analysis of the aspects to be observed. Hence their value in study of the learning process depends upon the reliability and validity of the original analysis.

Good teachers, we assume, provide a variety of opportunities for their students, designed to bring about many kinds of learning which will be reflected in thought, feeling, and action in many aspects of living. How well do they succeed? Formal tests in the past have largely been limited to tests of number and kind of concepts formed, as these can be recognized in tests of the paper and pencil variety. At present a number of tests purporting to measure changes in specific aspects of critical thinking are available. Our coöperating teachers are using these, as

well as others of their own making, to discover whether their students actually do improve in ability to think more critically as a result of the experiences provided for them in school.

In addition to formal tests, teachers have always used informal observation to tell them how their classes are progressing. Especially is this true for the more "intangible" aspects of learning—changes in ways of thinking and feeling. Teachers do not always identify just what clues they use when they declare positively that the "attitude of the class on such and such a subject has changed." We ask our coöperating teachers to do just that for us, to record the situations and responses on which they base their judgments that learning has taken place. Out of these we may be able to construct more formal tests. The Bureau of Evaluation at Ohio State University has already made a start in the construction of tests of attitudes and appreciations. However, formal tests can never fully take the place of informal observation as a means of evaluating learning. Perhaps there are some ideas which everyone should possess—certainly there are some ways of thinking which are valuable for all. Or it might be more exact to say there are some errors in thinking which it would be well for all to avoid. But in other fields of learning the most desirable achievement for each individual is that which contributes most to his welfare and makes him the most useful contributing member of a social group. The form of this achievement may vary widely in different individuals; hence evaluation must be individual. Except at a rather low level evaluation of changes in overt behavior must depend upon observation of individuals or the reports they bring of their activities. This evaluation is valuable even though it does not yield readily to statistical treatment. It is worth while finding what changes in overt behavior do occur as a result of learning although we may not be able to set up beforehand standards as to what these changes should be.

Similarly, constructive attitudes, interests, and appreciations are, with relatively few exceptions, significant only as they make life richer for individuals. Again, certain negative attitudes, unreasonable fears of snakes, of insects, of thunder, for example, detract from welfare. Elimination of these may be a goal for all. On the positive side, however, there is wide leeway. Collecting butterflies may represent a rare contribution to enrichment of life for some individuals, for others it may be worthless. Evaluation must always remain as an individual matter, dependent for critical evidence upon chance comments, questions, or opportunities for observation.

Our last category of changes resulting from learning we have described as a generalized attitude toward ourselves and the universe, a way of life, a philosophy of life. Science, with its continually changing concepts of human beings and the universe in which they live, must in the nature of things be in eternal conflict with any concept which becomes static, whether this concept be labeled "theology," "tradition," or simply "accepted point of view." A curious situation has existed with regard to science teaching and this conflict. On the one hand, science teachers have deliberately and conscientiously refused to consider the meaning of the facts which they are teaching for the conception of life which their students are building. They have attempted to present facts and to leave interpretation of these facts to the individual taught. On the other hand, the lay public is quite conscious of the significance of this contribution of science and is critical, not of the facts taught, but of their meaning in the lives of the learners. Science within a few generations has spread our ideas of space and time so far and so fast that the cozy little universe of our grandparents is

hopelessly lost. Ideas of cause and effect are rapidly taking the place of superstition, of dependence on chance and luck, in our conception of what happens to us. Often the resulting confusion is intensified by the failure of science teachers to make clear the distinction between established facts and scientific theories or hypotheses. Our students are faced with ideas quite contrary to those they have accepted unquestioningly, and to those held by elders and friends whose authority until now has been unchallenged. On the other hand, many people feel that science has helped them to an understanding and appreciation of themselves and their place in the universe which puts them at ease and allows them to move forward unhampered by senseless questions and misconceptions.

We need to know the interpretations students are putting on our teaching, how they are building the facts we present into their conceptions of the world, even though we do not deliberately strive to build up in them certain ways of looking at things. No one human being can dictate what should be the philosophy of life, the frame of reference for any other human being. A few fundamental characteristics of philosophies which have proved highly adaptive we may presume to describe. Such philosophies are free from superstitions; they are consistent with established facts. Evaluation of progress toward this goal must depend largely upon spontaneous questions and comments. The child who said, "First there were Adam and Eve. Then they must have died off and we had to start all over again with evolution, but I don't see why," made a valuable contribution to our ideas of what the facts she was learning were doing to her conception of the world. No formal test ever elicited such information.

For measuring learning, we ask our coöperating teachers to use whatever formal tests they can to discover changes in number of concepts, in ways of thinking, in overt behavior, in specific attitudes and interests, and in generalized attitudes toward themselves and the universe. We ask them, in addition, to identify for us those more indefinite and subjective clues by which they recognize such changes in students, realizing that these may constitute their most important contribution to the whole field of evaluation. Obviously, these latter measures of evaluation are not reserved for the end of a period of teaching. The records of what happens in classrooms are also the records we find most useful for evaluation.

THE CLEARING HOUSE

THE SCIENCE ROOM IN ELEMENTARY SCHOOLS

A Nuisance or a Joy, a Room of Real Value or an Example of Bad Housekeeping?

Not so many years ago it was my ambition to establish for each of our elementary schools a special science room, a room that would serve partly as a museum, partly as a convenient storeroom of science materials for the whole school, and also as a classroom for many science lessons. Being really enthusiastic about the project, I succeeded to the extent that in 1935, at the time of the State Survey, we had a science room in every school. Some of these rooms were reasonably well equipped. In the rooms in the four newest buildings there was a large waterproof demonstration desk, a sink, electricity, gas, and running water. There were tables and movable chairs. These rooms also had dark shades and a projection screen. Aquarium and terrarium tanks, window boxes, projection equipment, planting tables, and gardening tools were available. There was also a minimum of physical and chemical supplies such as might be needed for simple experiments and demonstrations. In addition, we had in each of these rooms numerous specimens, charts, collections, plants, small animals, and other similar contributions donated by teachers, children, and interested outsiders.

In each of the several older buildings we obtained for science use a room not needed as a classroom. These rooms were available in most cases at the time because of the "depression" policy of decreasing, where possible, the number of teachers, and hence classes, within a building. Some of these rooms had absolutely nothing in the way of equipment. Some were small, some on the dark side of the building. They had nothing much to recommend them, but they were, we thought, better than nothing. We then proceeded to get for them what we could in the way of museum specimens, apparatus, suitable furniture, and other equipment. We tried to sell the idea of a science room to the teachers.

Some five years have passed since most of these rooms were started. What has happened? Have they been of value? Have they become a real part of the school? Or are they more of a nuisance than anything else? Who is using them? Who is taking care of them? Can a teacher more conveniently and more profitably have her science lessons in her own classroom? Is there a place for "special rooms" in an integrated program? These are just a few of the questions that have come up in my own mind as I have attempted to determine the real value of a science room in each of our elementary schools.

In the first place, it must be said of course that no two of our schools are alike. Each presents its own problems; each has its own needs. Already in two schools the rooms designated for science have had to be taken over again as classrooms. In one of these buildings, however, the teachers in the upper grades were working under the coöperative group or departmental plan and when it became evident that some adjustment had to be made, the teacher of science and geography moved her "homeroom" into the "science room." Thus the lower grades can still get materials from the room, while the upper grades have the advantage of continuous contact with various charts, specimens, books, and collections, under the guidance of their science teacher. For the present, at

least, this arrangement seems to be fairly satisfactory for that particular school.

In another building the science room has this year been converted into a music room, it evidently having failed to find a place for itself that warranted its continued existence when the school became more crowded.

Three science rooms, each of which is used continuously and each of which is apparently filling a very real need in its own school, are described here in some detail, because each has evolved under quite different conditions and because as one of our visitors remarked recently, "It is necessary to evaluate work in various situations in order to get a point of view about one's own."

One of the first science rooms to become an assured success was in one of the newer buildings. It is ideally located "on the sunny side," on the same floor as the upper grade classrooms. It has gas, running water, demonstration table, ample closet space, exhibition shelves, etc. It has been used regularly from the beginning by all fifth and sixth grade classes in the school. It has been in charge of a teacher who has science, health, and geography in these grades, the school being one of those using the coöperative group organization. This teacher has obtained exhibits, charts, and pictures from many different sources (usually "free") and has also encouraged the children to raise, care for, and keep clean various small animals such as mice, turtles, snakes, fish, and alligators. The room is used also for slides and motion picture films and by the lower grades as a museum. Exhibits are neat and often changed or rearranged.

In another of the schools, in which there is a similar science room but where the cooperative group plan has not been used, there was for some time a question among the teachers as to what specific purposes a science room might serve and who might use it. This particular room was referred to at first as "Miss Dolbear's room," later as "Mrs. Neuner's room," and was seldom used by anyone, apparently for fear something might be disturbed or broken. The principal then decided to assign to one teacher and her class responsibility for keeping the "science room" in respectable order and sufficiently interesting so that all classes in the school would find it worth while. (Other teachers and their classes had other "extra" assignments consuming more or less the same amount of time and energy.) We have been especially fortunate in the teachers and classes who have had this responsibility and within the last two or three years there has been developed in this school an elementary science museum and laboratory that can hold its own with any anywhere. The room is used a good deal for visual instruction, which helps to further its value as a science room, since it very often happens that classes coming to see a motion picture remain to study the egg collection, to observe the aquarium, to ask questions about the terrarium, or whatnot. Sometimes they are moved to donate specimens or collections of their own, perhaps only a seashell or a round stone, but something that helps to make the room *theirs*.

One of the most popular science rooms is taken care of by everyone or by no one! Everyone interested (teachers, children, parents, principal, supervisor) adds materials, collections, apparatus. Every class in the school uses it, some much more than others. Most classes doing experiments manage somehow or other to find the necessary apparatus and to put it away again. Usually the required number of trowels or other implements can be found (or less can be made to serve the purpose). Extra plants or fish or snails are usually but not always available. Only occasionally does a snake get lost or a box of seedlings dry up completely. In five years the microscope has never been locked up and never lost. At almost any hour, morning, noon, or after school, when the

room is not in use by some class group there will be one, two, three, or more children setting up an experiment, looking for something, or just "looking around." At least five or six teachers use this room regularly for science work. But it is *not* a model of neatness and order except upon special occasions when specially cleaned up!

I have described here in some detail three distinctly different situations under which science rooms have evolved more or less successfully. There are at least three or four other of our science rooms that should certainly be considered as having attained a definite degree of success and usefulness. None of them, obviously, has attained perfection. Several factors, it seems to me, have entered into this development and several others have hindered it. I have enumerated them briefly as I see them at this time:

1. Running water, gas, and electricity, together with a demonstration table, are important although not absolutely necessary in an elementary science room.
2. Under the coöperative group plan one teacher is responsible for the physical set-up of the room. This makes for definiteness. Everyone's responsibility is too often no one's. If a teacher or committee is assigned to the science room in schools where the coöperative group plan is not used, these people should not have other additional assignments.
3. The science room may also be used to advantage for visual instruction (films, slides, etc.).
4. It is most useful to the primary children as a museum especially when they themselves contribute specimens for it.
5. If it is to be used for growing plants, it should be on the sunny side of the building, preferably, but since children are more important than plants or other equipment, all special rooms may very well be in the locations least desirable for regular classrooms.
6. Neither teacher nor children should be expected to sweep and dust the science room; but every class after using materials should clean them up and put them away. Exhibits should be changed occasionally, possibly with some other school.
7. The science room is definitely *not* the *sanctum sanctorum* of the science supervisor or of anyone else. It should be used every day in the week. It should be used by all children.
8. Not all science lessons should take place in the science room but it may well be used for experiments, demonstrations, plant propagation, etc., where special equipment is needed. It may under certain conditions be used by small groups of children for special projects, the classroom teacher assuming responsibility for them while there.
9. Work in elementary science may be carried on successfully especially in the primary grades, without a science room of any sort. A well equipped room, well taken care of, does nevertheless serve as a constant source of enrichment to the children and a convenience to a busy teacher who can find and use all in one place the materials that make science activities vital.

Please look back to the heading used for this discussion. What has been your own experience? What suggestions have you to offer? I should like very much to know.

Elsie Flint Neuner,
Supervisor of Elementary Science,
New Rochelle, N. Y.

EDITORIAL COMMENT AND REPORT

THE VOLUME ENDS—A NEW ONE IN PROSPECT

With this issue the sixteenth volume of EDUCATIONAL METHOD comes to a close. As we look back over the whole series, we feel that it has been an unusually valuable one; we hope our readers agree with us. To our special editors, Messrs. Moehlman, Wilson, Barnes, and Miss Lammel, we owe a debt of gratitude for their earnest and cheerful co-operation in carrying out our plan of presenting up-to-date, well-balanced, and comprehensive material on Social Studies, Arithmetic, Language as Social Behavior, and Natural Science. Each of these issues deserves a special place in your professional library, where it is easily accessible not only for your own use but for the guidance of others who look to you for help. At least one copy of EDUCATIONAL METHOD should be in every school. If you find your copies getting dog-eared, let us furnish fresh ones.[1]

The new volume, beginning in October, will be equally valuable, featuring special issues on such important topics as Reading, The Activity Program, The Direction of Study. Full announcement of these topics and the special editors will be made as soon as our plans are completed. The editorial staff is always glad to hear from its readers as to subjects which they believe should receive special attention, together with suggestions as to persons particularly competent to handle these subjects.

Be sure your name is on our mailing list. If your subscription expires with this issue, why not send in your renewal immediately? It will assure us of your continued support, and when the new school year opens, you will have one less thing to attend to.

SUMMER CONVENTION AT DETROIT

The 75th annual convention of the National Education Association will be held in Detroit, Michigan, June 27-July 1, 1937. In view of its accessibility and also its varied educational and recreational facilities, the choice of Michigan as the meeting place is a happy one; a very large attendance is expected.

In the May issue of the Association's *Journal* you will find a tentative outline of the program, the general plan of which is to devote the mornings to three section meetings appealing to different interests, the afternoons to group meetings of the various Departments of the N. E. A., and the evenings to general sessions with outstanding speakers. We note that Dr. Halford E. Luccock of Yale University Divinity School will speak at the Vesper Service on Sunday afternoon; that Governor Murphy of Michigan and Mayor Couzens of Detroit will be among those making addresses of welcome on Monday morning; and that the evening speakers will include such well-known authorities as Dr. Edmund E. Day, President of Cornell University, who will talk on "The Rôle of the Schools in Social Reform"; Mrs. Mary R. Beard on "Society's Interest in Human Values"; Stuart Chase on "Conservation of Natural Resources"; and the Honorable Josh Lee, United States Senator from Oklahoma, on "The Elimination of War." On Thursday afternoon the Antioch College Players will present their Horace Mann Play, which we understand is eminently worth while. President Pratt and Secretary Givens are to be congratulated on having arranged a program that is designed to give all types

[1] We can supply all but the one on Arithmetic. The price of each special issue is 50 cents, with liberal discounts on quantities.

of school people not only inspiration but much practical help in their educational problems.

OUR DEPARTMENT PROGRAM

In former years the Department of Supervisors and Directors of Instruction has held only one session in connection with the summer meeting of the N. E. A. This year, however, it was decided to hold two meetings at Detroit, one of them to deal with the topic of the 1938 yearbook, "The Technique of Coöperation." Accordingly Miss Bader, our new president, has arranged two very interesting group discussions:

TUESDAY, JUNE 29, 2:00 P. M.

Corinthian Lodge Room, Masonic Temple

Presiding: Edith M. Bader, Assistant Superintendent of Schools, Ann Arbor, Mich.

Panel Discussion: *Coöperation in a Democratic Society.*

Leader: Mr. Ray Johns, Secretary, Michigan Y. M. C. A.

Invited participants:

Henry Tape, Principal, Lincoln Consolidated School, Michigan State Teachers College, Ypsilanti, Mich.

Dorothy Hubbard, State Supervisor, Workers Education, Michigan W. P. A.

Reba Harris, State Department of Public Health, Louisville, Ky.

David Sonquist, Ashland Folk School, Grant, Mich.

Rev. Thomas Pryer, Whitefield Methodist Church, Detroit, Mich.

WEDNESDAY, JUNE 30, 2:00 P. M.

Corinthian Lodge Room, Masonic Temple

Presiding: Eva Palmer, President of the Michigan Conference of Elementary Supervisors

Topic: *The Coöperative Approach to Creative Leadership in Education.*

Needed research in coöperative techniques in education:

The problem presented by members of the steering committee for the 1938 yearbook:

S. A. Courtis, Professor of Education, University of Michigan

Eldridge T. McSwain, Assistant Professor of Education, Northwestern University

Discussion by Hearing Board:

Leader: Paul J. Misner, Superintendent of Schools, Glencoe, Ill.

Jean Betzner, Assistant Professor of Education, Teachers College, Columbia University, New York

Miles E. Cary, Principal, McKinley High School, Honolulu, T. H.

F. W. Brown, Superintendent, Ottawa Hills School, Toledo, Ohio.

Nancy O. Devers, State Department of Public Instruction, Raleigh, N. C.

INFORMAL RECEPTION AND TEA

The Michigan Conference of Elementary Supervisors and the supervisory staff of the Detroit Public Schools will be at home to visiting members of the Department of Supervisors and Directors of Instruction on Tuesday afternoon, June 29, from four to six o'clock (place to be announced later). This gracious invitation will make it possible for us to renew old friendships and to make valuable new contacts.

REGISTRATION

Registration at Detroit opens on Saturday, June 26, at 9:00 A. M. at the Auditorium. Report promptly, present your N. E. A. membership card, receive your badge and program, then go forth to enjoy the meetings in which you are most interested. Your friends will be able to locate you through the registration desk; telegrams may be forwarded to you. Failure to register promptly makes contacts difficult, and it may mean that you will miss an important message.

Membership in the National Education Association is prerequisite to membership in any department.

CONFERENCE ON ELEMENTARY EDUCATION

Of particular interest to supervisors of elementary education is the Conference on Elementary Education at the University of Michigan, July 5-16, which is being sponsored by the Department of Elementary School Principals of the N. E. A. This is an unusual opportunity to do intensive work for two weeks following the convention, under particularly pleasant conditions. Dean Edmonson has placed the course in charge of Professor L. W. Keeler. Among those who will lead in the conference discussions are: Dr. S. A. Courtis, Dr. Clifford Woody, Dr. Agnes Samuelson, Dr. Willard C. Olson, Dr. Henry J. Otto, Dr. William G. Carr, and Dr. Paul T. Rankin. The University Elementary School, with six units of children from three to fourteen years of age, will be in session so that concrete information regarding the latest methods may be gained through visitation during the period of the course. The work may be taken for credit if desired; the tuition fee is $15.00. For full information regarding this conference, address Dr. L. W. Keeler, School of Education, University of Michigan, Ann Arbor, Michigan.

AMERICAN EDUCATION WEEK

American Education Week, sponsored by the National Education Association in cooperation with the United States Office of Education and the American Legion, will be observed November 7-13, 1937. The general theme, "Education and Our National Life," has been chosen.

Your program for this significant occasion should be planned as far ahead as possible in order to gain the most fruitful results. Write to the National Education Association for materials.

HEADQUARTERS NEWS

Good News from North Carolina!

Word has come to the headquarters office that an organization of Supervisors and Directors of Instruction as part of the North Carolina Education Association was perfected at the meeting in Durham on April 23. The officers elected were: President, Superintendent S. G. Hawfield of Cabarrus County, Concord; Vice President, Elizabeth Hyman, East Carolina Teachers College, Greenville; Secretary-Treasurer, Nancy O. Devers, State Department of Public Instruction, Raleigh.

The meeting was called to order and presided over by Miss Devers, who is our State Promotion Committee Chairman in North Carolina. It was pointed out that the main purposes of the organization are: first, the coördination, extension, and possible modification of all types of supervision now in effect in North Carolina; second, the coordination of supervision with instructional training of teachers for the improvement and extension of the teacher training curriculum. In presenting ten major educational needs in North Carolina, Miss Devers emphasized the following in particular: (a) the principal free from other school responsibilities to supervise fifty per cent of his time, more or less, as determined by the type of school; (b) general supervision by local instructional advisers or consultants for counties and for cities; (c) a coördinated and expanded teacher-training curriculum as an outgrowth of school needs in North Carolina; (d) extended rather than extension teacher training.

The meeting was well attended and the general discussion led to an emphasis on the following:

1. The training of teachers as an activity based on work of the instructors and

supervisors in the schools with prospective teachers—a laboratory approach.
2. The importance of a good training school for every teacher-training institution.
3. The supervisor with a humanistic approach and as a director of research.
4. We do not have a state system of supervision in North Carolina.
5. Superintendents are not trained for supervision and are not doing instructional supervision.
6. More thought and effort should be given to the improvement of instruction.
7. In supervision the principal has an important part but cannot do his best without assistance of a good coördinating instructional officer for the school system.

The decision to organize this group in North Carolina and to affiliate with the national Department of Supervisors and Directors of Instruction was reached with a unanimous vote.

Promotion Committee

Most of the members of the Promotion Committee have signified their willingness to serve for another year, and we are therefore in a position to start the fall campaign with united fervor. A card catalogue of the persons in supervisory positions in cities of 10,000 and over is being compiled in the office of the Executive Secretary at headquarters. This will take several months to complete, but meanwhile you will be interested to know that this information is being gathered and that as soon as it is available it will be supplied upon request to state chairmen.

It is hoped that there will be an opportunity for those of us who are at Detroit to get together for a discussion of plans. Further word regarding this will be sent by mail to the chairmen.

A Forthcoming Study of Curriculum Development

The following note regarding our Tenth Yearbook has been received from the chairman, Professor Henry Harap:

The Joint Committee of the Department of Supervisors and Directors of Instruction and the Society for Curriculum Study has held a series of five meetings for the planning and development of a volume on the curriculum. The project now is in the manuscript stage and the book should be off the press early in the fall. The commercial edition will be published and distributed by the D. Appleton-Century Company.

The purpose of the book is to make available to school people an up-to-date summary of thought and practice in curriculum development. The volume is divided into two parts. The first part includes the theoretical bases of the curriculum and certain general aspects of planning for curriculum development. The second part consists of an appraisal of cases in curriculum development in state and county school systems, in city school systems, and in individual schools and classrooms. It also considers the education of the teacher for the performance of her functions as conceived in the book.

The contributors include: Edith M. Bader, Assistant Superintendent of Schools, Ann Arbor, Michigan; O. G. Brim, Professor of Education, Ohio State University; Prudence Cutright, Assistant Superintendent, Minneapolis; Will French, Superintendent of Schools, Long Beach, California; Harold Hand, Professor of Education, Stanford University; Charles W. Knudsen, Professor of Education, George Peabody College, Nashville, Tennessee; E. O. Melby, Dean of the School of Education, Northwestern University; Paul T. Rankin, Supervising Director of Curriculum and Research, Board of Education, Detroit; Laura Zirbes, Professor of Education, Ohio State University; Henry Harap, Chairman, Professor of Education, Ohio State University. Rarely has a yearbook had such a perfect blending of practical and theoretical workers.

FEDERAL AID

Just because the dark cloud of disappointment in the outcome of the hearings on the Harrison-Black-Fletcher Bill temporarily casts its gloom about us, we must not for a moment stop thinking, talking, and working toward the goal—"Good Schools for All the People!"

THE READER'S GUIDE

CHILDREN'S CIVIC INFORMATION

During the ten years, 1924-1935, seven investigations were completed on the general subject of the "nature and amount of civic information possessed by sixth grade children." These investigations were conducted in such widely separated localities as Chicago, Cincinnati, North Dakota, and Los Angeles. The results of the seven studies have been brought together into the present volume under the general editorship of Dr. William H. Burton of the University of Southern California.[1]

In seeking to discover the civic information possessed by children an objective approach in the form of inventory tests was used. The study deals with factual information only, and information that was available in 1924. However complete the selection of facts is, it fails to consider the effects of knowledge on conduct.

The test on civic information was derived from many sources, as problems deemed important by representative citizens, as indicated by newspaper references, as mentioned in political platforms, and as found in state and city courses of study and in textbooks. The selection of items for the test included such political terms as *precinct, amendment,* and *jury;* such economic terms as *consumer, franchise,* and *injunction;* and such sociological terms as *alimony, pauper,* and *morality* —157 in all.

Unlike most studies of this type, there are very few statistical tables. The editor states that his "aim has been to prepare a simple, straightforward, easily understood report immediately useful to curriculum makers, teachers, supervisors, and parents." He further thinks that much of the mathematical mysticism included in statistical tables thoroughly confuses many readers who are seriously interested in the facts which are obscured in the tables and formulas.

Probably the most interesting part of the study is that which deals with the sources from which children's civic information is derived. The sources are classified under four headings: (1) outside contacts, (2) general reading, (3) home influences, and (4) school influences. The studies tend to show the influence of the schools.

A few of the more important conclusions are: (1) There was practically no variation in the nature of, but considerable variation in the amount of civic information possessed by the several regional, economic, or racial groups. (2) Boys were regularly and consistently superior to the girls throughout, for the information studied. (3) There has been no marked change in the nature and amount of pupil information over the ten-year period. (4) Information is gained from many sources but the influence of the school increased steadily through the grades. (5) The economic status of the home was the factor most closely correlated with the amount of information possessed by pupils.

The authors recognize the need for further study along this and similar lines; in fact they mention as many as sixteen kinds of studies which are suggested by and related to the study they have made.

As a book on the civic information of children, its nature and amount, and where it is obtained, this volume has value for all persons interested in and responsible for the civic education of our youth.

C. C. Barnes
Detroit, Mich.

[1] *Children's Civic Information, 1924-1935.* By William H. Burton and Others. Los Angeles: University of Southern California Press, 1936.

HISTORY IN THE MIDDLE GRADES

In *Learning and Teaching History in the Middle Grades*,[2] Miss Kelty supplies a very helpful manual for use with the textbooks which she has written for the intermediate grades. Part Two, comprising 540 of the book's 654 pages, is devoted to detailed directions for teaching the units into which her books are organized. Part One is given over to discussion of the psychological and social foundations that underlie the selection and organization of materials and the teaching techniques recommended by Miss Kelty. Eight special objectives of history in the middle grades are stated in terms of the development of the following desirable changes in children: (1) a lasting interest in history, (2) the ability "to comprehend a coherent narrative of successive events in a unit movement," (3) ability to visualize clearly the overt aspects of the historical scene, (4) understanding of vocabulary terms and of large movements as a whole, (5) information as to the most important persons, places, and dates in history, (6) the ability to use books, (7) skills in picture and map interpretation, and (8) simple reasoning processes in history. Materials and method are conditioned by these objectives.

The books were planned to include "coherent, connected units dealing with the supremely important social and industrial and economic topics which affect the child's everyday existence," and to develop these units with a "wealth of stirring incident and colorful detail" that contributes to understanding. Comprehension is stressed also in the recommended teaching techniques which aim to combine the best features of the Morrison "unit of understanding" plan with those of the "activity program," and include the following features:

1. *The conversational approach.* Informal conversation between pupils and teacher is used as a means of arousing children's interest and securing a "favorable emotional tone" in regard to the new unit.
2. *Reading and study.* In order to care for individual differences the class is divided into two groups: independent readers and lower-ability group. Each child in the independent group reads first from the text, then tests his understanding by answering the study-guide questions that are given at the end of the chapter or supplied by the teacher. The independent reader next reads from additional texts, and when these no longer seem to add to his store of new ideas he reads from books which may treat the topic from various points of view, listed as Extensive Reading. The lower-ability group, seated together, first hear the teacher tell the main outline of the story orally and then read the story section by section under her direction, being guided by the same type of questions as would be used in a silent reading period. When the entire story has been read, this group answers the study-guide questions. For each unit, a list of recreational reading materials to be read in leisure time is posted where children of both groups can refer to it easily.
3. *The discussion.* The two reading groups are combined for a class discussion, during which complete answers are given to the study-guide questions, understanding of basic vocabulary is emphasized, and children are carefully directed in the study of pictures, graphs, maps and charts. Music, lantern slides, and other "multisensory aids" are used to build meaningful concepts.
4. *General activities.* Creative activities, both group and individual, supply approaches to meaning other than reading through drawing, painting, construction, dramatization, trips, singing, oral reports, and other activities. The value of some of the suggested activities as means of arriving at understandings may be questioned, particularly those involving dramatization and the writing of imaginary letters and speeches; for example, the attempt to dramatize "the meeting of the Crusaders with the Mohammedans" or to give "the speech that George Washington

[2] *Learning and Teaching History in the Middle Grades.* By Mary G. Kelty. Ginn and Company, 1936.

might have made to the Assembly of Virginia, urging the importance of settling the West." It is unfortunate, also, that the few illustrations in the book are of the type of sand-table scene that has been found likely to build distorted and inaccurate concepts.

Questions that provide a basis for applying the knowledges gained to present-day conditions and exercises in reasoning complete the list of general activities. These are excellent lists of questions that encourage thoughtful evaluation and interpretation of the materials under consideration. In the writer's judgment, these two features are the most worth while among the recommended techniques.

5. *Drill games.* Suggestions for drill cards to be used in matching basic vocabulary with definitions are given for each unit. Even though the definitions are stated in child language, the drill might easily result in mere verbalism, since the ability to match "route" with "a road or way used in travel" may depend upon mere memorization rather than upon understanding.
6. *Testing and remedial work.* Objective tests of basic facts, of understanding, of reasoning, and of study skills follow each story and each unit. The testing is to be followed by remedial work.

Many teachers, the reviewer included, will not agree with all of Miss Kelty's recommendations nor care to follow exactly the method outlined in her teaching techniques. However, *Learning and Teaching History in the Middle Grades* contains many helpful suggestions that may be applied with whatever text or method a teacher is using.

MABEL SNEDAKER
University of Iowa.

SOUNDING THE ALARM

The Department of Superintendence concludes a series of three yearbooks on the present crisis with a volume [3] on what John Citizen ought to know and how to tell him. Of the twelve chapters in the book, eleven are devoted to critical discussion of social and educational conditions and one to report of practical steps that may be taken to induce the public to do something about them.

As a whole, this yearbook is much more radical than its immediate predecessor. Its authors pull no punches when they are attacking the shortcomings of either present-day society or present-day education. Some school superintendents will be thankful to know that not many laymen will be likely to work through a book like this. At any rate they can turn to the last chapter and gain many good ideas on how to appeal to their constituency.

The committee are on sure ground when they urge the necessity of adult education. In the long run the schools will be what the people demand that they should be and provide the means of making them so. There is still widespread faith in education but no corresponding perception of its bearing upon the future of democracy. The purpose of this book is to indicate the dangers of which the public must become aware and to inspire the leaders in education to the task of enlightening them. The movement for forums under the direction of school officers will be given strong impetus by it. The text itself, together with the authorities cited, will assist such officers in fitting themselves to organize forums and prepare their programs.

As for the pupils, the committee holds that they should be helped to attain the right attitudes toward controversial questions and should consider both merits and demerits of the existing order. They should learn to recognize and appraise propaganda and develop a wise "sales resistance" to it.

This is perhaps the most vigorous publication the Department has put out. No-

[3] *The Improvement of Education:* An Interpretation for Democracy. By Frank G. Pickell and Others. Fifteenth Yearbook of the Department of Superintendence (now American Association of School Administrators) of the National Education Association, Washington, D. C., 1937.

where but in America is such frank self-examination possible. The complacent will be shocked—let us hope for their own good—by it. Yet it offers no panaceas. On the contrary, it holds with democracy and endeavors to show the democratic ideal can be realized. Such a book is needed and highly valuable at this time. It is fortunate that at least one leader in each of 4,000 communities has access to it.

J. F. H.

AN EVALUATION OF FREE READING

Voluntary reading on the part of high school students now largely replaces the line-by-line with-glossary-in-hand study of "classics" so long carried on in imitation of the study of Latin. Students who learn to hate reading through being "disciplined" are proportionately fewer than they were twenty years ago. It is important to find out, if possible, just what is happening in the "free reading" program and this Miss LaBrant undertook to do for the Ohio State University School.[4]

The history of one class was followed through the three years of the senior high school. The average number of pupils was fifty-seven. In all, 3,974 complete books were read, including 1,947 different titles. This does not include short poems, magazines, etc., nor reading required in various subjects of study. Narrative fiction, drama, and biography lead, in that order.

The evaluation of the program that is presented employs criteria that were selected with the help of the pupils. These do not include an estimate of the literary value of the books used. Increased facility in handling non-fiction, contact with varied cultures, and, above all, appeal to genuine, permanent interests were emphasized.

The writer calls attention to the prominence of present-day writers; since 1920, more than half are American. Serious writing increases rapidly in interest from grade to grade. Girls read more than boys. She concludes that a free reading program may develop an active interest in books that provoke thought far stronger than adolescents commonly have. Her report ends with a classified list of the books read by the class.

J. F. H.

SIGNIFICANT ARTICLES

The Head of the Legion States His Position

Commander Colmery says the American Legion does not wish to dictate school policies. Writing in *Clearing House* for March, he reviews the efforts which the Legion has made to support education, citing the large percentage of illiteracy among soldiers drafted for the World War as evidence of the need. The Legion has established schools of citizenship for the foreign born, presented medals for scholarship, distributed thousands of copies of the Flag Code, and sponsored oratorical and essay contests. The Legion believes in the present form of government and holds that there should be adequate training in good citizenship. Academic freedom should be preserved and fair discussion of controversial subjects, including Communism, should be permitted and encouraged. Only American citizens should be admitted to our training schools for teachers.

The Easy Chair Proves Not So Easy

While a young instructor at Northwestern University, Bernard De Voto indulged in more or less vitriolic attacks upon schools of education. During intervals between writing somewhat sensational criticisms of books, he returns to the attack on his pet aversion. A recent screed of his in the "Easy Chair" of *Harpers Magazine* provides

[4] *An Evaluation of the Free Reading Program in Grades Ten, Eleven and Twelve.* By Lou L. LaBrant. Ohio State University Press, 1936.

the text for a symposium of well-known educators in *Educational Trends* for March-April, published by the School of Education of Northwestern University. None of the fifteen writers represented can approve of De Voto's strictures. Some of them are indignant, some dismiss him in few words as wrong, some analyze his position seriously, and one or two resort to humor, the most deadly weapon of all. The editors of *Educational Trends* defend their action in giving space to the discussion by saying that De Voto appears to represent "an attack on democratic public education which will force our schools to serve as agencies for the imposition of a caste system in America." And then again he may represent merely the group of ambitious young writers who seek to attract notice by attacking something.

Psychology and the Curriculum

An address by Kilpatrick on "Psychological Bases and Their Implications for the Curriculum" is reported in *Teachers College Record* for March. Foremost among the problems to be solved he places adjustment of personality—we must fit the school constructively to the personality of the individual. Next comes the problem of building intelligence. This involves a process essentially social. A wide range of abilities must be provided for. Certain matters are now in controversy; three in particular are organismic as opposed to atomistic psychology, the rôle of acceptance, and learning for immediate use. All three have important bearing on the organization of the school program: the first emphasizes goal-seeking and unity of experience; the second means that acceptance for action is necessary for effective learning. It is characteristic of moment-by-moment living. Application of these principles will lead to proper subordination of subject matter and drill on the so-called tools of learning.

Progress of Manuscript Writing

The American Penman for April contains an excellent paper on "Manuscript Writing in First and Second Grades" read by Miss Edith U. Conard before the Handwriting Section of the Department of Supervisors and Directors of Instruction at the convention in New Orleans. She explains the origin of this form by saying that it has been developed from the Roman alphabet found on the Trojan column in Rome. It was adopted in England in 1912 and introduced into this country by Miss Marjorie Wise in 1922. Among the benefits claimed are: less strain for young children, greater legibility, aid in learning to read, and early acquisition of a usable medium of expression. Letters written separately at first may be joined in the fourth or fifth grade, and a cursive script gradually developed. Standards of excellence have been worked out and specifications as to pens and paper. Miss Conard closed her account with a review of the research that has been carried on in this field.

Criteria for a Social Studies Program

Those who do not have access to the Fourteenth Yearbook of the Department of Superintendence (now the American Association of School Administrators) will find one of the most significant chapters in it summarized by Dr. Paul T. Rankin in *Social Studies* for March. Ten criteria of excellence are stated, explained, and supported, as follows: (1) comprehension and balance, (2) vertical articulation, (3) horizontal articulation, (4) reality of learning situations, (5) self-integrated learning, (6) adaptation to the maturity of the learner, (7) adaptation to community characteristics, (8) adaptation to individual differences, (9) flexibility, (10) contribution to the general objectives of the school program as a whole. The writer calls attention to three types of organization possible: separate subjects, general social studies courses, and social studies as a factor

in an integrated program; he suggests the application of the ten criteria to each of these to determine which is likely to prove most effective.

Continuous Curriculum Revision in New York State

Commissioner Morrison concludes a review of several years' progress in curriculum reconstruction in New York state by saying that if present plans for state-wide coöperation are carried out a new pattern for continuous curriculum revision will have been set. In his article in *New York Education* for April he reviews the work of some ten years as carried on by local curriculum committees, classroom teachers, superintendents, and the State Education Department. A series of reports on cardinal objectives culminated in 1933 with a study of "Trends in Unit Teaching." Several communities have published results of creative teaching. Special committees have prepared state curriculum guides for teachers of young children and for the teaching of health. New syllabi in English, arithmetic, and science are in active preparation. A social studies conference held last May has paved the way for advance in that field. Both child growth and changes in the social order must be given more attention in the future than they have had in the past.

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America's March Toward Democracy. By Harold Rugg. Boston: Ginn and Co., 1937. Pp. 515. Illus. $1.96.

The Wonderful Wonders of One-Two-Three. By David Eugene Smith. New York: McFarlane, Ward, McFarlane, Inc. Pp. 48. Illus. $1.00.

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